Volume 22 DECEMBER, 1938 Number 12

BULLETIN
of the
American Association *of* Petroleum Geologists

CONTENTS

Comparison of Upper Cretaceous Deposits of Gulf Region and Western Interior Region *By Lloyd W. Stephenson and John B. Reeside, Jr.* 1629

Stratigraphy of Upper Cretaceous Series in Mississippi and Alabama *By Lloyd W. Stephenson and W. H. Monroe* 1639

Bellevue Oil Field, Bossier Parish, Louisiana *By A. F. Crider* 1658

Relation of Rough Creek Fault of Kentucky to the Ouachita Deformation *By William L. Russell* 1682

GEOLOGICAL NOTES

An Historical Document of Interest to Petroleum Geologists *By Wilber Stout* 1687

REVIEWS AND NEW PUBLICATIONS

Sediment-Heft (Symposium on Sediments) *By Parker D. Trask* 1692

Petroleum Technology in 1937 *By Eugene A. Stephenson* 1693

Recent Publications 1693

THE ASSOCIATION ROUND TABLE

Thirty-Year Oil Fields *By Wallace E. Pratt* 1698

Membership Applications Approved for Publication 1699

Twenty-Fourth Annual Meeting, Oklahoma City, March 22-24, 1939 1700

Mid-Year Meeting, El Paso, September 27-October 2, 1938. Abstracts 1701

South Texas Section Tenth Annual Meeting, Corpus Christi, October 21-22, 1938. *By C. C. Miller* 1712

Pacific Section Fifteenth Annual Meeting, November 3-4. Abstracts *By Roy M. Barnes* 1714

Membership Applications Approved for Publication 1718

Association Committees 1719

AT HOME AND ABROAD

Current News and Personal Items of the Profession 1720

INDEX OF VOLUME 22 1723

COPYRIGHT, 1938, BY THE AMERICAN ASSOCIATION OF PETROLEUM GEOLOGISTS, INC.

CABLE TOOL OPERATORS

MAKE A BULL'S EYE

ON EVERY RUN WITH A

BAKER *Cable Tool* CORE BARREL

BAKER Affords These Important Advantages:

- Higher percentage of recoveries in a wider range of formations
- Faster running time
- Lower maintenance cost
- Simplicity of operation
- Maximum safety in service
- Longer life
- Low initial cost

Complete details concerning this economical and efficient tool will be gladly furnished upon request—or see your 1938 Composite Catalog.

BAKER OIL TOOLS, INC.

Telephone JEfferson 8211 – HUNTINGTON PARK, CALIFORNIA – 2959 E. Slauson Ave.
Telephone WAyside 2108 – HOUSTON PLANT AND OFFICE – 6023 Navigation Blvd.

MID-CONTINENT OFFICE AND WAREHOUSE:
Telephone 2-8083 – Tulsa, Oklahoma – 312 East Fourth Street

WEST TEXAS BRANCH OFFICE
Odessa, Texas – Telephone 217

EXPORT SALES OFFICE
Rm. 1914 – 19 Rector St., New York City
Tel. Digby 4-1610

ROCKY MOUNTAIN HEADQUARTERS
Tel. 2220 – Casper, Wyoming – Box 1469

BAKER CABLE TOOL CORE BARREL

BULLETIN

of the

AMERICAN ASSOCIATION OF PETROLEUM GEOLOGISTS

OFFICE OF PUBLICATION, 608 WRIGHT BUILDING, TULSA, OKLAHOMA

WALTER A. VER WIEBE, *Editor*

GEOLOGICAL DEPARTMENT, UNIVERSITY OF WICHITA, WICHITA, KANSAS

ASSOCIATE EDITORS

GENERAL	K. C. HEALD, Gulf Oil Corporation, Box 1166, Pittsburgh, Pa.
	HUGH D. MISER, U. S. Geological Survey, Washington, D. C.
	THERON WASSON, Room 2308, 35 E. Wacker Drive, Chicago, Ill.
GEOPHYSICS	G. H. WESTBY, Seismograph Service Corporation, Tulsa, Okla.
APPALACHIANS	
North	JOHN R. REEVES, Penn-York Natural Gas Corporation, Buffalo, N.Y.
South	WILLIAM O. ZIEBOLD, 1572 Virginia Street, Charleston, W. Va.
NORTH CENTRAL STATES	R. B. NEWCOMBE, 303 South Main Street, Mount Pleasant, Mich.
KANSAS	ANTHONY FOLGER, Gulf Oil Corporation, Wichita, Kan.
OKLAHOMA	
Western	ROBERT H. DOTT, Oklahoma Geological Survey, Norman, Okla.
Eastern	SHERWOOD BUCKSTAFF, Shell Petroleum Corporation, Box 1191, Tulsa, Okla.
TEXAS	
North and Central	J. B. LOVEJOY, Gulf Oil Corporation, Fort Worth, Tex.
Northeastern	E. A. WENDLANDT, Humble Oil and Refining Company, Tyler, Tex.
Panhandle	JOHN E. GALLEY, Shell Petroleum Corporation, Tulsa, Okla.
San Antonio	HERSCHEL H. COOPER, 1015 Milam Building, San Antonio, Tex.
Permian Basin	HAL P. BYBEE, Box 2101, University Station, Austin, Tex.
GULF COAST	SIDNEY A. JUDSON, Texas Gulf Producing Company, Houston, Tex.
	MARCUS A. HANNA, Gulf Oil Corporation, Houston, Tex.
ARKANSAS AND NORTH LOUISIANA	C. L. MOODY, Ohio Oil Company, Shreveport, La.
ROCKY MOUNTAINS	A. E. BRAINERD, Continental Oil Company, Denver, Colo.
CALIFORNIA	W. S. W. KEW, Standard Oil Company, Los Angeles, Calif.
	W. D. KLEINPELL, Box 1131, Bakersfield, Calif.
FOREIGN	
General	MARGARET C. COBB, Room 2703, 120 Broadway, New York, N. Y.
Europe	W. A. J. M. VAN WATERSCHOOT VAN DER GRACHT, Staatstoezicht op de Mijnen, Heerlen, Holland
Canada	THEODORE A. LINK, Imperial Oil, Ltd., Calgary, Alberta
South America	HOLLIS D. HEDBERG Mene Grande Oil Co., Apt. 35, Ciudad Bolivar, Venezuela

THE BULLETIN OF THE AMERICAN ASSOCIATION OF PETROLEUM GEOLOGISTS is published by the Association on the 15th of each month. Editorial and publication office, 608 Wright Building, Tulsa, Oklahoma. Post Office Box 979. Cable address, AAPGEOL.

THE SUBSCRIPTION PRICE to non-members of the Association is $15.00 per year (separate numbers, $1.50) prepaid to addresses in the United States. For addresses outside the United States, an additional charge of $0.40 is made on each subscription to cover extra wrapping and handling.

British agent: Thomas Murby & Co., 1 Fleet Lane, Ludgate Circus, London, E. C. 4.

German agent: Max Weg, Inselstrasse 20, Leipzig CI, Germany.

CLAIMS FOR NON-RECEIPT of preceding numbers of THE BULLETIN must be sent Association headquarters within three months of the date of publication in order to be filled gratis.

BACK NUMBERS OF THE BULLETIN, as available, can be ordered from Association headquarters. Paper-bound Vol. 2 (1918), $4.00; Vol. 3 (1919), $5.00. Cloth-bound Vol. 5 (1921), $12.00; Vols. 11 (1927) to 16 (1932), Vols. 18 (1934) to 21 (1937), each $17.00. Other volumes, many separate numbers, and a few nearly complete sets are available. Descriptive price list sent on request. Special prices to members and associates. Discounts to libraries. *Structure of Typical American Oil Fields*, Vol. II (1929), $7.00 ($5.00 to members and associates). *Stratigraphy of Plains of Southern Alberta* (1931), $1.50. *Geology of Natural Gas* (1935), $6.00 ($4.50 to members and associates). *Geology of Tampico Region, Mexico* (1936), $4.50 ($3.50 to members and associates). *Structural Evolution of Southern California* (1936), $2.00. *Gulf Coast Oil Fields* (1936), $4.00 ($3.00 to members and associates). *Comprehensive Index, 1917–1936* (1937), $3.00 (to members and associates: free; extra copy, $2.00). *Miocene Stratigraphy of California* (1938), $5.00 ($4.50 to members and associates).

THE BULLETIN furnishes thirty-five reprints of major papers. Additional reprints and covers for all or part are furnished at cost. ORDERS FOR REPRINTS should accompany corrected galley proof.

Association Headquarters—608 Wright Building, 115 and 117 West Third Street, Tulsa, Oklahoma.

Communications about the Bulletin, manuscripts, editorial matters, subscriptions, special rates to public and university libraries, publications, membership, change of address, advertising rates, and other Association business should be addressed to

THE AMERICAN ASSOCIATION OF PETROLEUM GEOLOGISTS, INC.

BOX 979

TULSA, OKLAHOMA

Entered as second-class matter at the Post Office at Tulsa, Oklahoma, and at the Post Office at Menasha, Wisconsin, under the Act of March 3, 1879. Acceptance for mailing at special rate of postage provided for in section 1103, Act of October 3, 1917, authorized March 9, 1923.

THE AMERICAN ASSOCIATION OF PETROLEUM GEOLOGISTS, INC.

(Organized at Tulsa, Oklahoma, February 10, 1917, as the Southwestern Association of Petroleum Geologists. Present name adopted, February 16, 1918. Incorporated in Colorado, April 23, 1924. Domesticated in Oklahoma, February 9, 1925.)

OFFICERS FOR THE YEAR ENDING MARCH, 1939

DONALD C. BARTON, *President*, Houston, Texas
HAROLD W. HOOTS, *Vice-President*, Glendale, California
IRA H. CRAM, *Secretary-Treasurer*, Tulsa, Oklahoma
WALTER A. VER WIEBE, *Editor*, Wichita, Kansas
(The foregoing officers, together with the *Past-President*, H. B. FUQUA, Fort Worth, Texas, constitute the Executive Committee.)

DISTRICT REPRESENTATIVES

(Representatives terms expire immediately after annual meetings of the years shown in parentheses)

Amarillo: Carl C Anderson (40) Amarillo, Tex.
Appalachian: Paul H. Price (39) Morgantown, W. Va.
Canada: S. E. Slipper (39), Calgary, Canada
Capital: Arthur A. Baker (40), Washington, D. C.
Dallas: P. W. McFarland (40), Dallas, Tex.
East Oklahoma: Frederic A. Bush (39), R. B. Rutledge (39), W. B. Wilson (40), Tulsa, Okla.
Fort Worth: Charles E. Yager (39), Fort Worth, Tex.
Great Lakes: Benjamin F. Hake (39), Indianapolis, Ind.
Houston: Orval L. Brace (39), David Perry Olcott (39), Wallace C. Thompson (40) Houston, Tex.
Mexico: William A. Baker, Jr. (39), Houston, Tex.
New Mexico: Harold S. Cave (39), Roswell, N. Mex.
New York: W. T. Thom, Jr. (39), Princeton, N.J.
Pacific Coast: A. Arthur Curtice (39), Homer J. Steiny (39), E. J. Bartosh (40), Los Angeles, Calif.
Rocky Mountains: J. Harlan Johnson (39), Golden, Colo.
Shreveport: A. F. Crider (39), Shreveport, La.
South America: James A. Tong (39), Caracas, Venezuela
So. Permian Basin: Cary P. Butcher (39), Midland, Tex.
South Texas: Fred P. Shayes (39), Beeville; R. F. Schoolfield (39), San Antonio, Tex.
Tyler: A. C. Wright (39), Tyler, Tex.
West Oklahoma: V. G. Hill (39), Shawnee, Okla.
Wichita: Edward A. Koester (39), Wichita, Kan.
Wichita Falls: Virgil Pettigrew (40), Wichita Falls, Tex.

DIVISION REPRESENTATIVES

Paleontology and Mineralogy

E. H. Sellards (39), Austin, Tex.
Henry V. Howe (39), Baton Rouge, La.

PACIFIC SECTION (Chartered, March, 1925)

W. S. W. KEW, *President*, Standard Oil Company, Los Angeles, California
E. WAYNE GALLIHER, *Secretary-Treasurer*, 930 Petroleum Securities Building, Los Angeles, California
Membership restricted to members of the Association in good standing, residing in Pacific Coast states. Dues: $1.50 per year.

SOUTH TEXAS SECTION (Chartered, April 1929)

W. A. MALEY, *President*, Humble Oil and Refining Company, Corpus Christi, Texas
C. C. MILLER, *Secretary-Treasurer*, The Texas Company, Corpus Christi, Texas
Membership limited to persons eligible to Association membership. Dues: $2.50. Annual meeting in October.

MARACAIBO SECTION (Chartered, April, 1930)

JOHN L. KALB, *President*, Lago Petroleum Corporation, Caripito, Venezuela

DIVISION OF PALEONTOLOGY AND MINERALOGY
SOCIETY OF ECONOMIC PALEONTOLOGISTS AND MINERALOGISTS

(Organized, March, 1927; affiliated, March, 1928; chartered, technical division, April, 1930)

E. H. SELLARDS, *President*, Austin, Texas
HENRY V. HOWE, *Secretary-Treasurer*, Louisiana State University, Baton Rouge, Louisiana
SEND DUES, SUBSCRIPTIONS, AND ORDERS FOR BACK NUMBERS TO BOX 979, TULSA, OKLAHOMA.

The Society and the Paleontological Society jointly issue six times a year the *Journal of Paleontology*, Raymond C. Moore, University of Kansas, Lawrence, Kansas, and C. Wythe Cooke, U. S. Geological Survey, Washington, D. C., editors: subscription, $6.00. The *Journal of Sedimentary Petrology*, W. H. Twenhofel, editor, University of Wisconsin, Madison, Wisconsin, is issued three times a year: subscription, $3.00. Single copies, *Journal of Paleontology*, $2.00; *Journal of Sedimentary Petrology*, $1.50. Society dues: with *Jour. Pal.*, $6.00; with *Jour. Sed. Petrology*, $3.00; with both, $8.00 per year.

AFFILIATED SOCIETIES

(Dates of affiliation in parentheses)

Alberta Society of Petroleum Geologists, Calgary, Alberta, Can. (31). S. E. Slipper, Secy., 215 Sixth Avenue, West
Appalachian Geological Society, Charleston, W. Virginia (31). Charles Brewer, Jr., Secy., Godfrey L. Cabot, Inc., Box 348
Ardmore Geological Society, Ardmore, Oklahoma (36). J. P. Gill, Secy., Sinclair Prairie Oil Company
Dallas Petroleum Geologists, Dallas, Texas (35). W. W. Clawson, Secy., Magnolia Petroleum Company
East Texas Geological Society, Tyler, Texas (32). F. J. Schempf, Secy., Stanolind Oil and Gas Company
Fort Worth Geological Society, Fort Worth, Texas (31). Herbert H. Bradfield, Secy., The Texas Company
Houston Geological Society, Houston, Texas (32). Carleton D. Speed, Jr., Secy., Speed Oil Company
Kansas Geological Society, Wichita, Kansas (31). Forrest E. Wimbish, Secy., 537 North Chautauqua
Michigan Geological Society, Saginaw, Mich. (37). R. W. Beck, Secy., 240 Goff Building
North Texas Geological Society, Wichita Falls, Texas (38). Orion A. Daniel, Secy., 814 Hamilton Building
Oklahoma City Geological Society, Oklahoma City Oklahoma (31). C. E. Hamilton, Secy., 504 Hightower Building
Panhandle Geological Society, Amarillo, Texas (32). G. R. Carter, Secy., Gulf Oil Corporation
Shawnee Geological Society, Shawnee, Oklahoma (31). J. Lawrence Muir, Secy., Amerada Petroleum Corporation
Shreveport Geological Society, Shreveport, Louisiana (32). E. F. Miller, Secy., Oliphant Oil Company, 927 Commercial Bldg.
Society of Exploration Geophysicists, Houston, Tex. (32). H. B. Peacock, Secy., 825 Esperson Building
South Louisiana Geological Society, Lake Charles, La. (37). W. R. Canada, Secy., 207 Weber Building
Southwestern Geological Society, Austin, Texas (37). W. C. Ikins, Secy., Department of Geology, University of Texas
Tulsa Geological Society, Tulsa, Oklahoma (31). L. A. Johnston, Secy., Sunray Oil Company
Western Kentucky Geological Society, Owensboro, Kentucky (38). R. E. Knipe, Secy., The Ohio Oil Company
West Texas Geological Society, Midland, Texas (38). W. C. Fritz, Secy., Skelly Oil Company

A New A. A. P. G. Book

Ready in January

MIOCENE STRATIGRAPHY OF CALIFORNIA

By ROBERT M. KLEINPELL

This Work Establishes a Standard Chronologic-Biostratigraphic Section for the Miocene of California and Compares It with the Typical Stratigraphic Sequence of the Tertiary of Europe

CONDENSED TABLE OF CONTENTS

	Page
Introduction and Scope	1
The Reliz Canyon Section	7
General Stratigraphy	7
The Foraminifera	9
Paleogeographic Significance of the Foraminiferal Assemblages	11
Correlation and Age	20
Historical Summary of Foraminiferal Data	20
Analysis of Stratigraphic Distribution of Foraminifera in the California "Miocene"	79
Chronologic-Biostratigraphic Classification of the Marine Middle Tertiary ("Miocene") of California	87
Formational Correlations within the California Province	159
Stratigraphic Position of Reliz Canyon Section with Respect to California Middle Tertiary Stage Sequence	159
Stratigraphic Position of Some Typical California Formations with Respect to Middle Tertiary Stage Sequence	160
Age of California Stage Sequence with Respect to European Tertiary Column	168
Systematic Catalogue	182
Index	357

400+ pages; 14 line drawings, including a large correlation chart in pocket; 22 full-tone plates of Foraminifera; 18 tables (check lists, and a range chart of 15 pages) Bound in blue cloth; gold stamped; paper jacket; 6x9 inches.

PRICE: $5.00, POSTPAID

($4.50 TO A.A.P.G. MEMBERS AND ASSOCIATES)

The American Association of Petroleum Geologists
BOX 979, TULSA, OKLAHOMA, U.S.A.

London: Thomas Murby & Co., 1, Fleet Lane, E.C. 4

SURWEL

GYROSCOPIC CLINOGRAPH

Sets Another Remarkable Record

The Superior Oil Company's deep well at Rio Bravo, California, was double surveyed when at a depth of 11,322 feet with the "SURWEL" Gyroscopic Clinograph attached to the drill pipe making the round trip in 5½ hours.

The Superior Oil—Geisenger #2 Rio Bravo, Kern Co., California

FROM THE LOG

In-run started at	9h 28m 00sec.
Bottom reached at	11h 41m 00sec.
Out-run completed at	2h 55m 00sec.
Total time for two surveys	5h 27m 00sec.
Closure between In and Out-run	6.1′
Maximum temperature recorded	218°F.

Records taken every 45 feet.

●

Sperry-Sun congratulates The Superior Oil Company and their California staff for successfully completing one of the fastest round trips ever made at such depth—a splendid performance!

SPERRY-SUN WELL SURVEYING COMPANY

1608 Walnut Street, Philadelphia, Pa.

Houston, Texas — 3118 Blodgett Ave.

Santa Barbara, Cal. — 1409 E. Valley Road

(U.S. Patents 1,124,068; 1,812,994; 1,898,473; 1,959,141; 1,960,038; 2,006,556; 2,012,138; 2,012,152; 2,012,455; 2,012,456 and others pending)

MAGNIFIERS – *of fine optical quality*

Spencer Magnifiers provide a most convenient means of investigating details which are too fine for the unaided eye to see. They are manufactured with the same traditional care as Spencer microscope objectives.

Spencer Triple Aplanats are corrected both spherically and chromatically. They are noted for their large flat field, brilliance and long working distance.

Spencer Doublets, although not as well corrected as Triple Aplanats, give excellent central definition.

The Spencer Utility Magnifier, a doublet, covers a wide field and is ideal for routine inspection.

HAND MAGNIFIERS in folding case (6X, 9X, 12X, 15X, 18X, 24X magnifications)

Triple Aplanats..... $7.50
Doublets..... 3.25

} Available in plain, black lacquered mounts for use in dissecting microscopes at $1.00 less.

UTILITY (4.5X) MAGNIFIER on black lacquered stand $8.50

Write Dept. M29 for further details.

Spencer Lens Company

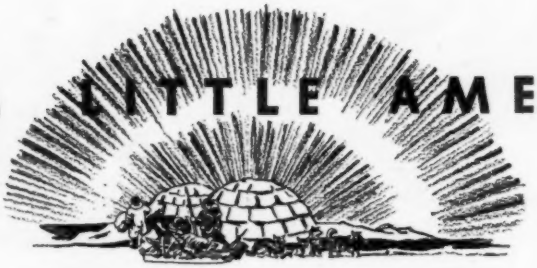
MICROSCOPES
MICROTOMES
PHOTOMICROGRAPHIC EQUIPMENT

SPENCER BUFFALO U.S.A.

REFRACTOMETERS
COLORIMETERS
SPECTROMETERS
PROJECTORS

WORLD WIDE EXPERIENCE

FROM LITTLE AMERICA



SSC Experience embracing the United States, Canada, Little America, Argentina, New Zealand, Trinidad, Venezuela, Dutch East Indies, Europe and Asia has resulted in the discovery of 43 NEW PRODUCING OIL FIELDS, an imposing contribution by one Company to the oil reserves of the world.

TO THE TROPICS

Seismograph Service Corporation

CONSULTING EXPLORATION GEOPHYSICISTS

KENNEDY BUILDING

TULSA, OKLAHOMA, U. S. A.

Bulletin Advertisers

American Askania Corporation .....
American Paulin System xix
Baker Oil Tools, Inc. .....Inside front cover
Baroid Sales Department xxx
William M. Barret, Inc. .....
Bausch and Lomb .....
Borntraeger Brothers xviii
Dowell Incorporated viii
Eastman Kodak Stores, Inc. .....
Eastman Oil Well Survey Company .....
Economic Geology Publishing Company ..xvii
George E. Failing Supply Company xxv
First Natl. Bank and Trust Co. of Tulsa ..xviii
Geophysical Service, Inc. ....Inside back cover
Geotechnical Corporation xviii
Gulf Publishing Company xx
Haloid Company .....
Hughes Tool Company ....Outside back cover
Illinois Powder Manufacturing Company ..xvii
Independent Exploration Company .....
International Geophysics, Inc. xxvi
Journal of Geology .....
Journal of Paleontology xxviii
Journal of Sedimentary Petrology xxviii
Lane-Wells Company .....
E. Leitz, Inc. xxx
Reed Roller Bit Company xxxii
Revue de Géologie xvii
Schlumberger Well Surveying Corporation ....
Seismic Explorations, Inc. .....
Seismograph Service Corporation vi
Spencer Lens v
Sperry-Sun Well Surveying Company iv
Subterrex xxvii
Sullivan Machinery Company xxxi
Tobin Aerial Surveys xxix
Triangle Blue Print and Supply Company ....
United Geophysical Company xxiii
Verlag für Fachliteratur xvii

PROFESSIONAL CARDS

Joseph L. Adler xii
William M. Barret x
Donald C. Barton xii
Elfred Beck xi
Brokaw, Dixon & McKee...xi
William F. Brown x
D'Arcy M. Cashin xii
Frederick G. Clapp xi
Willard J. Classen ix
Richard R. Crandall ix
Cummins & Berger xiii
Ronald K. DeFord x
E. DeGolyer xii
Alexander Deussen xii
David Donoghue xii
Robert H. Durward xiii
J. E. Eaton ix
R. H. Fash xii
A. H. Garner xi
R. L. Ginter xi
Paul P. Goudkoff ix
C. A. Heiland x
Malvin G. Hoffman xi
Holl and Oborne x
Hudnall & Pirtle xiii
Huntley & Huntley xii
John S. Ivy xiii
W. P. Jenny xiii
Vernon L. King ix
H. Klaus .....xi, xii
R. W. Laughlin xi
U. R. Laves xii
Marvin Lee x
A. I. Levorsen xi
George C. Matson xii
Geo. C. McGhee xiii
Wm. C. McGlothlin xiii
Chas. Gill Morgan x
L. C. Morgan x
R. H. Palmer x
Dabney E. Petty xiii
John L. Rich xi
E. E. Rosaire xiii
W. G. Saville xiii
J. P. Schumacher xiii
A. T. Schwennesen xiii
R. W. Sherman ix
Walter Stalder ix
R. L. Triplett x
Harold Vance xiii
G. H. Westby xii

GEOLOGICAL AND GEOPHYSICAL SOCIETIES

Appalachian xvi
Ardmore xv
Dallas xv
East Texas xv
Exploration Geophysicists .xvi
Fort Worth xvi
Houston xvi
Kansas xiv
Michigan xiv
North Texas xvi
Oklahoma City xvi
Rocky Mountain xiv
Shawnee xv
Shreveport xiv
South Louisiana xiv
South Texas xvi
Southwestern xvi
Stratigraphic xv
Tulsa xv
West Texas xvi

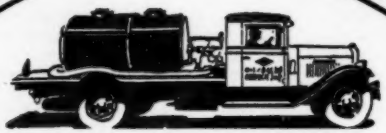
Articles for January *Bulletin*

Bottom Sediments of Lake Pontchartrain, Louisiana
By R. A. STEINMAYER

Stratigraphic Features of Reef Ridge Shale in Southern California
By STANLEY S. SIEGFUS

Subsurface Stratigraphy of Santa Maria Valley Oil Field and Adjacent Parts of Santa Maria Valley, California.
By CHARLES REITER CANFIELD

Park City Beds on Southwest Flank of Uinta Mountains, Utah
By STEWART WILLIAMS



Out in Front Again!

NEW—DOWELL *RED* SOLVENT

FOR ASPHALTIC PARAFFIN REMOVAL

Dowell *Red* Solvent is the result of extensive study of paraffin problems throughout the United States. It is a running mate to the highly successful Dowell Orange Solvent, formerly known as Dowell Paraffin Solvent, and was especially developed for more effective action on the less pure, or asphaltic paraffins.

Dowell *Red* Solvent has already proved itself in the field. Operators are enthusiastic over results. This new product is a knock-out—more effective than any other solvent now in use—with a much faster rate of reaction. Yet a smaller amount of material is required. And it does the job at lower cost because it comes in concentrated form and is diluted in the field.

With the development of Dowell *Red* Solvent, Dowell offers a paraffin solvent to meet a long felt need in practically every field. To reduce shut-down losses, cut pulling and pumping costs, Dowell paraffin solvents combine maximum efficiency with minimum cost.

DOWELL FORMATION PLUG

For Chemical Control of Water

A new and much needed service to seal off formation water. Write for information.

DOWELL INCORPORATED

Subsidiary of THE DOW CHEMICAL COMPANY

General Office: Kennedy Bldg., Tulsa, Okla.

Now in MEXICO . . . DOWELL SOCIEDAD ANONIMA, San Juan de Letran No. 6, Desp. 101
Apartado Postal 24-24, Mexico, D.F., Mexico
Esquina: 2a. 6 3a. Avenidas. La Isleta, Apartado Postal 438, Tampico, Tamaulipas, Mexico

DISTRICT OFFICES

Allegan, Michigan
Borger, Texas
Bossier City, Louisiana
Calgary, Alberta
Casper, Wyoming
Cody, Wyoming
Douglas, Wyoming
Eureka, Kansas
Flora, Illinois
Fort Worth, Texas
Graham, Texas
Great Bend, Kansas
Hays, Kansas
Hobbs, New Mexico
Houston, Texas
Lawrenceville, Illinois
Long Beach, California
Longview, Texas
McCamey, Texas
Midland, Texas
Mt. Pleasant, Michigan
Newton, Kansas
Owensboro, Kentucky
Okotoks, Alberta
Seagraves, Texas
Seguin, Texas
Seminole, Oklahoma
Shreveport, Louisiana
Stamford, Texas
Tulsa, Oklahoma
Wichita, Kansas

DOWELL

OIL AND GAS WELL CHEMICAL SERVICE

Volume 22 Number 12

BULLETIN
of the
AMERICAN ASSOCIATION OF
PETROLEUM GEOLOGISTS

DECEMBER, 1938

COMPARISON OF UPPER CRETACEOUS DEPOSITS OF GULF REGION AND WESTERN INTERIOR REGION[1]

LLOYD W. STEPHENSON[2] AND JOHN B. REESIDE, JR.[2]
Washington, D.C.

ABSTRACT

The Upper Cretaceous deposits of the Gulf region are mainly of marine origin. Taking the east-central Texas section as a standard, the deposits present different sequences of units from place to place in both directions away from this section, both to the southwest and to the northeast. The sequence in east-central Texas resembles that in the Great Plains of the western interior. No other sequences in the two regions are similar to each other.

The Upper Cretaceous of the western interior may be roughly divided into belts representing three types of sequence: (1) the Great Plains sequence—mainly fine sediments, and of marine origin; (2) the Rocky Mountain sequence—continental and marine sediments, much sandstone, considerable coal, increasing in coarseness westward; (3) a western marginal belt dominantly nonmarine, coarse sandstones, conglomerates, and coals; sequence usually incomplete.

Fossils are abundant in both regions. Although many species are present in each region that are not found in the other, enough of them are common or closely analogous to permit a fairly close correlation of the deposits. Dependence for correlation is placed chiefly on the mollusks.

Although there is at present no physical connection between the Upper Cretaceous deposits of the Gulf region and those of the western interior, the presence of common and closely analogous species throughout the series in the two areas indicates that there was such a connection. Presumably the connecting deposits that once existed in some part of the area now separating the two regions have been removed by erosion.

INTRODUCTION

In the region of the present Gulf Coastal Plain the sea had been present since the middle of Lower Cretaceous time, and the dawn of the Upper Cretaceous found marine waters covering the Coastal Plain to, and some miles beyond, its inner edge. In the interior region, both in the north and in the south, marine waters had been present in the later part of Lower Cretaceous time, but these had apparently with-

[1] Read before the Association at New Orleans, March 16, 1938, and published with the permission of the director, Geological Survey, United States Department of the Interior. Manuscript received, September 9, 1938.

[2] Geological Survey.

drawn before the end of the Lower Cretaceous. Somewhat after the beginning of Upper Cretaceous time the waters returned to the interior region to form the last of the North American inland seas, spreading rather rapidly to their maximum extent. The paleontologic data available indicate communication between the Gulf and inland seas during most of Upper Cretaceous time, but no physical connection is now known between the deposits that were laid down in the two seas. The areas of outcrop in the Gulf and interior regions are shown on Figure 1.

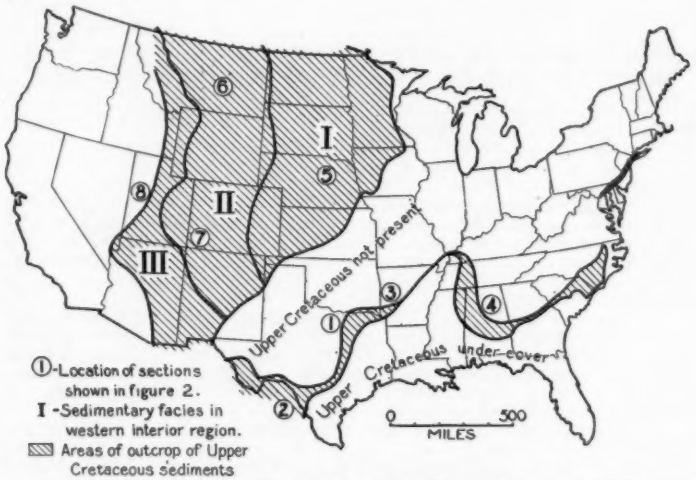


FIG. 1.—Areas of outcrop of Upper Cretaceous sediments in the Coastal Plain and interior regions, the location of the sections shown in Figure 2, and the distribution of sedimentary facies in the western interior.

The Upper Cretaceous sediments in both regions are varied, and the classification and nomenclature applied to them differ from place to place. A discussion of this subject would lead far afield, and it will serve the present purpose to consider only a few representative sections.

PHYSICAL CHARACTERS

THE GULF REGION

The most complete section in the Gulf region, and one which may serve as a standard, is the classic section in east-central Texas (Column 1, Fig. 2). Excluding the uppermost beds of the Comanche series, which are of debatable Cenomanian age, the Upper Cretaceous series includes, in ascending order, the Woodbine sand, Eagle Ford

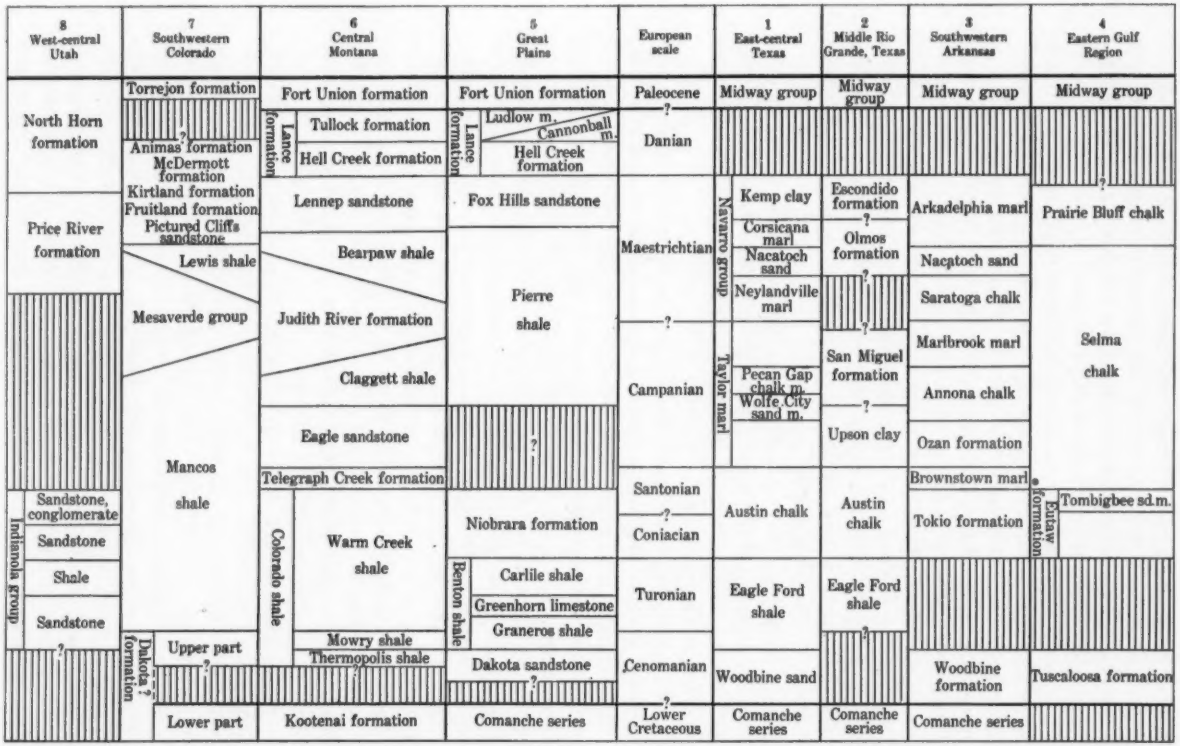


FIG. 2.—Selected sections of Upper Cretaceous sediments in the Gulf and western interior regions. (See Figure 1.)

shale, Austin chalk, Taylor marl (including the Wolfe City sand and Pecan Gap chalk members), and the Navarro group (Neylandville marl, Nacatoch sand, Corsicana marl, and Kemp clay). The aggregate thickness of this series is about 3,000 feet.

Traced both southwest and northeast from east-central Texas the sequence changes markedly, owing in part to the intertonguing of different kinds of materials, in part to the merging of one kind of material into another, and in part to the more or less complete overlapping of certain of the units upon underlying units.

In the middle Rio Grande region, where the basal unit, the Woodbine sand, is missing, the sequence of formational units is as follows: Eagle Ford shale, Austin chalk, Upson clay, San Miguel formation, Olmos formation (notable for its commercial coals), and Escondido formation (Column 2, Fig. 2).

In southwestern Arkansas the sequence is: Woodbine formation, Tokio formation, Brownstown marl, Ozan formation, Annona chalk, Marlbrook marl, Saratoga chalk, Nacatoch sand, and Arkadelphia marl (Column 3, Fig. 2).

In the eastern Gulf region the typical sequence is: Tuscaloosa formation, Eutaw formation (including the Tombigbee sand member), Selma chalk, and Prairie Bluff chalk (Column 4, Fig. 2).

There are interruptions due to nondeposition or erosion in all of these sequences. Even in east-central Texas, where the sequence is most complete, some of the stratigraphic breaks are of considerable importance. The more notable unconformities are: at the base of the series, between the Woodbine and Eagle Ford, between the Eagle Ford and the Austin, between the Austin and the Taylor, between the Taylor and the Neylandville, between the Nacatoch and the Corsicana, and at the top of the series between the Kemp clay and the overlying Tertiary. There is a tendency for the stratigraphic breaks to widen both to the southwest and to the northeast away from the east-central Texas sequence.

The strata composing the units dip gently to the south and southeast and pass beneath overlying Tertiary sediments. Taken as a whole the Upper Cretaceous sediments of the Gulf region are relatively unconsolidated or only partly consolidated. Locally, layers and masses have been hardened by cementation with calcium carbonate or iron oxides. Vulcanism is indicated by bentonite beds which are well distributed through the section, and locally by volcanic necks.

Although the Upper Cretaceous series in the Gulf region is made up mainly of sediments of marine origin, there are certain exceptions. The basal formations, Woodbine in the western Gulf and Tuscaloosa

in the east, are composed of sediments laid down in littoral marine waters, in lagoons, estuaries, and on low plains above sea level. Some of the terminal units away from the more central areas of deeper marine sedimentation are of similar shallow marine and nonmarine origin. The Olmos formation in the middle Rio Grande region, with its commercial coals, is a notable example of nonmarine sediments.

The chalk units are a notable part of the series of deposits and are believed to represent epochs when the ocean waters were relatively free from detrital material and only moderately deep. The Austin chalk, the oldest of the chalks, the Pecan Gap chalk member of the Taylor marl, and the Annona chalk, record such epochs in the Texas and Arkansas areas. The Selma chalk of the eastern Gulf region appears to indicate a long period when the streams of the present Appalachian highland area brought little sediment into the Gulf.

WESTERN INTERIOR REGION

In the interior region the sediments came dominantly from the west (Fig. 1). They may be viewed as constituting three types of sequence in north-south belts: (1) an eastern belt of marine, dominantly fine sediments—chalks and muds with little sand (Great Plains sequence); (2) a middle belt of mixed continental and marine sediments, with much sandstone, increasing in coarseness westward and containing coal deposits (Rocky Mountain sequence); (3) a western belt, dominantly coarse, with sandstones and conglomerates, in considerable part nonmarine, and, as a rule, an incomplete sequence (marginal sequence). The most complete section is along the boundary between the middle and eastern belts.

The sequence in the Great Plains region, because it was earliest studied, may be taken as a standard (Column 5, Fig. 2). Here the Dakota sandstone is followed by the Benton unit with Graneros shale below, Greenhorn limestone in the middle, and Carlile shale above. In Kansas the lower part of the Carlile is a chalk. Next above comes the Niobrara formation with a limestone member below and a chalk member above, and then the Pierre shale and Fox Hills sandstone, followed by the nonmarine Hell Creek formation. The next higher units, the Cannonball marine member and the equivalent Ludlow lignitic member, are of debated significance, though generally considered Cretaceous. The Cannonball member is the last marine deposit in the interior region.

In central Montana (Column 6, Fig. 2) the sequence includes the Colorado group, in which have been recognized the Thermopolis shale, the Mowry shale, and the Warm Creek shale. On it rests the Tele-

graph Creek formation, the Eagle sandstone, the Claggett shale, the nonmarine Judith River formation, the Bearpaw shale, and the nonmarine Lennep sandstone. On this rests the nonmarine Lance formation, which has been separated in some areas into the Hell Creek formation and the Tullock formation, a coal-bearing unit.

In southwestern Colorado (Column 7, Fig. 2), the Dakota? sandstone is followed by a thick marine formation, the Mancos shale; and this in turn by a group of sandy formations, the middle one nonmarine and coal-bearing (Mesaverde group). This group is followed by a marine shale, the Lewis, and a marine sandstone, the Pictured Cliffs; then by a series of nonmarine formations, the Fruitland formation, the Kirtland shale, the McDermott formation, and the Animas formation—the latter two made up largely of andesitic debris.

In west-central Utah (Column 8, Fig. 2), a group of formations including conglomerates, sandstones, finer sandstones and shales, in part marine, in part nonmarine and coal-bearing (Indianola group), forms the lower part of the sequence. This group is followed by the conglomeratic, nonmarine Price River formation and the finer-grained North Horn formation. The latter extends into the Tertiary, but no readily identifiable plane of division between Cretaceous and Tertiary has been found.

Unconformities may be numerous, but few are clearly shown. Lithification is generally of high order and relatively resistant rocks are the rule. Evidence of vulcanism exists throughout the sequence in the form of bentonite, and is particularly notable in the early part (Mowry and Aspen formations) and in the later part (Livingston, Animas, Denver formations). Coal is relatively plentiful in the two western belts, mainly of earlier (Colorado) age in the west and of later (Montana) age in the middle belt. It occurs in the eastern belt but is of very late age (Lance, Laramie, and later). Chalks are noteworthy only in the eastern belt.

COMPARISONS

The sequence in east-central Texas resembles most that in the Great Plains—Woodbine compares with Dakota, Eagle Ford with Benton, Austin with Niobrara, Taylor with the lower part of the Pierre, Navarro with the upper part of the Pierre and the Fox Hills. The eastern Gulf sequence with its calcareous deposits, and the Rocky Mountain and marginal sequences with their coarse deposits and coal beds, have no close counterparts. The degree of lithification is relatively low in the Gulf region and high in the interior region. The beginning of the Upper Cretaceous is not sharply marked by physical features in the western Gulf region, and it is in the interior

region, whereas the end of the Upper Cretaceous is sharply marked in the Gulf region and is not in the interior.

PALEONTOLOGIC CHARACTER

In both the Gulf and interior regions fossils are abundant, and most of the major groups of organisms are represented. Chief reliance for correlation is placed on the marine invertebrates, and these permit a matching of principal time units. In both regions the marine faunas are dominantly of a pelecypod-gastropod facies, with cephalopods subordinate but important. Corals and brachiopods are rare in both regions. Other groups of organisms differ in importance in the two regions.

In the Gulf region vertebrates and nonmarine invertebrates are relatively rare; plants are abundant only in the shallow water and nonmarine facies near the base of the series; foraminiferal faunas are large and varied; bryozoans, echinoids, and crustaceans are relatively common and of normal size. Some of the marine invertebrates occupy narrow zones having linear extent in outcrop of as much as 450 miles; others are particularly abundant in and characteristic of larger units, such as *Exogyra costata*. The following is a rough indication of faunal zones (not named or numbered) that have been recognized in the Upper Cretaceous series; they are arranged in approximate stratigraphic sequence beginning with the youngest.

Zones typically developed in	*Important species*
Kemp clay	*Trigonia angulicostata* Gabb, *Titanosarcolites oddsensis* Stephenson, *Turritella* n. sp. (with 2 spiral lirae), *Discoscaphites* n. sp., *Sphenodiscus pleurisepta* (Conrad), *Sphenodiscus* spp.
Corsicana marl, Prairie Bluff chalk, Owl Creek formation, Providence sand	*Idonearca capax* Conrad, *Exogyra costata* Say (variety with narrow costae), *Plicatula mullicensis* Weller?, *Crassatella vadosa* Morton, *Discoscaphites* spp., *Sphenodiscus* spp.
Nacatoch sand, Ripley formation	*Exogyra costata* Say (variety with medium and narrow costae), *Sphenodiscus* spp., *Nostoceras* spp.
Neylandville marl, equivalent zones in Ripley formation and Selma chalk	*Exogyra cancellata* Stephenson, *E. costata* Say (with medium and wide costae), *Anomia tellinoides* Morton, *Placenticeras meeki* Böhm
Taylor marl, upper Austin chalk, and equivalent zones in Selma chalk, Tombigbee sand member of Eutaw formation, etc.	*Exogyra ponderosa* Roemer (sensu lato), *Placenticeras* spp.
Pecan Gap chalk member of Taylor marl	*Echinocorys texana* (Cragin), *Terebratulina filosa* Conrad, *Diploschiza cretacea* Conrad, *Baculites asper* Morton

Zones typically developed in	*Important species*
Taylor marl (lower)	*Mortoniceras* aff. *delawarense* (Morton), *Baculites asper* Morton
Austin chalk (upper)	
subzone e	*Ostrea travisana* Stephenson
d	*Ostrea centerensis* Stephenson
c	*Exogyra tigrina* Stephenson
b	*Gryphaea aucella* Roemer, *Exogyra ponderosa* Roemer (typical), *Exogyra laeviuscula* Roemer, *Mortoniceras texanum* Roemer
a	*Gryphaea wratheri* Stephenson, *Inoceramus undulatoplicatus* Roemer
Tombigbee sand member of Eutaw formation (upper Austin age)	*Marsupites americanus* Springer, *Exogyra ponderosa* Roemer (variety), *Gryphaea wratheri* Stephenson, *Mortoniceras* spp.
Austin chalk (lower)	*Inoceramus deformis* Meek?
Eagle Ford shale (upper)	*Ostrea lugubris* Conrad, *Prionocyclus* spp.
Eagle Ford shale (upper middle)	*Prionotropis* aff. *woolgari* (Mantell)
Eagle Ford shale (lower middle)	*Inoceramus labiatus* Schlotheim, *Inoceramus fragilis* Hall and Meek, *Metoicoceras whitei* Hyatt, *Baculites gracilis* Shumard
Eagle Ford shale (lower)	*Exogyra columbella* Meek, *Acanthoceras* spp., *Epengonoceras* spp.
Woodbine sand (upper)	*Arca* (*Barbatia*) *micronema* (Meek), *Ostrea soleniscus* Meek, *Modiolus filisculptus* Cragin, *Epengonoceras* spp., *Metoicoceras swallowi* (Shumard)

Apparently the interior marine faunas are in part of boreal origin; they are less like those of the Gulf region in the north and progressively more like them southward. Ten widespread marine zones have been recognized and a nonmarine zone above them (*Triceratops*). A still higher marine zone of small extent (Cannonball) has been considered Cretaceous but may well be basal Eocene (Paleocene of European section). These zones are as follows.

Zone	*Typically developed in*	*Important species*
12	Cannonball marine member of Lance formation	Marine fauna without cephalopods
11	Lower part of Lance and Laramie formations	*Triceratops*, fresh-water invertebrates
10	Fox Hills sandstone	*Sphenodiscus* spp., *Discoscaphites conradi* (Morton) of Meek
9	Pierre shale	*Acanthoscaphites nodosus* (Owen), *Placenticeras intercalare* Meek
8	Eagle sandstone	*Scaphites hippocrepis* DeKay
7	Telegraph Creek formation	*Desmoscaphites bassleri* Reeside
6	Upper part of Niobrara formation	*Inoceramus* (*Haploscapha*) *grandis* Conrad
5	Lower part of Niobrara formation	*Inoceramus deformis* Meek, coiled *Inoceramus*
4	Upper part of Carlile shale	*Prionocyclus wyomingensis* Meek, *Scaphites warreni* Meek and Hayden

FIG. 3.—Ranges of identical and analogous species of Upper Cretaceous fossils in the Gulf (solid lines) and western interior (broken lines) regions of the United States.

Zone	*Typically developed in*	*Important species*
3	Lower part of Carlile shale	*Prionotropis woolgari* (Mantell), *Scaphites larvaeformis* Meek and Hayden
2	Greenhorn limestone	*Inoceramus labiatus* Schlotheim, *Metoicoceras whitei* Hyatt
1	Graneros shale	*Gryphaea newberryi* Stanton, *Exogyra columbella* Meek, *Exogyra suborbiculata* Lamarck, *Epengonoceras* spp., *Acanthoceras* spp.

In the western interior plants are especially abundant in the middle and western belts, but in the main have not yet been thoroughly studied. Vertebrates are important in the uppermost part of the section and characterize several useful zones in nonmarine strata. Several nonmarine invertebrate faunas are useful in correlation—Bear River, Judith River, Lance, Laramie. Foraminiferal faunas are small and relatively little varied; bryozoans, echinoids, and crustaceans are extremely rare, and small when present.

Though hundreds of macrofossils are restricted to either one region or the other, a considerable number of identical or analogous species are known and are useful in correlation. The ranges of some of these are shown in Figure 3 and will not be taken up in detail. The general grouping is clear, solid lines indicating ranges in the Gulf region and broken lines ranges in the interior region.

An additional means of correlation is provided by species that occur in one American region and in Europe, though not in the other American region. *Uintacrinus* occurs in the upper Niobrara and in the European Santonian; *Marsupites americanus* occurs in the Tombigbee sand member of the Eutaw, and the analogous *M. testudinarius* in the Santonian; *Mortoniceras texanum* occurs in the Austin and in the Santonian. Other such species are exemplified by the coiled species of *Inoceramus*, *Exogyra olisiponensis*, *Hoplitoplacenticeras vari*, species of *Menuites*, and of *Bostrychoceras*.

Certain differences are striking and a few may be cited. The wide distribution and relative abundance of *Exogyra costata* and *Exogyra ponderosa* in the Gulf region are not matched in the interior. The wide distribution and practical importance in correlation of the scaphite group of ammonites in the interior region is not matched in the Gulf region. The pelecypod genus *Trigonia* and the cephalopod genus *Belemnitella* are not uncommon at some levels in the Gulf region; both are uncommon fossils in the interior. The range of the ammonite genus *Sphenodiscus* seems much more restricted in the interior region than in the Gulf region. On the other hand *Ostrea soleniscus* is much more restricted in the Gulf region than in the interior.

BULLETIN OF THE AMERICAN ASSOCIATION OF PETROLEUM GEOLOGISTS
VOL. 22, NO. 12 (DECEMBER, 1938), PP. 1639-1657, 8 FIGS.

STRATIGRAPHY OF UPPER CRETACEOUS SERIES IN MISSISSIPPI AND ALABAMA[1]

LLOYD W. STEPHENSON[2] AND WATSON H. MONROE[2]
Washington, D.C.

ABSTRACT

The Upper Cretaceous sediments of the eastern Gulf region crop out in a crescentic band around the southwestern end of the plunging Appalachian Highlands in a belt 500 miles long and up to 75 miles wide. Their maximum thickness is estimated to be about 2,300 feet.

The Tuscaloosa formation is thickest in west-central Alabama, but thins northwestward to a feather edge in Tennessee, and thins toward the east to about 250 feet near Chattahoochee River. The Eutaw formation overlies the Tuscaloosa, from which it is separated by an important unconformity. The Eutaw thins both toward the northwest and toward the east, only the upper part being exposed in Tennessee and in Georgia. The Selma chalk overlies the Eutaw formation unconformably. It consists of nearly 900 feet of chalk in west-central Alabama, but is broken by a minor unconformity or diastem about 300 feet above its base, a few feet above a thin but persistent zone of hard, pure limestone layers interbedded with chalk, the Arcola limestone member. Northwestward in Mississippi the lower third of the Selma passes by merging and intertonguing into the Coffee sand; the upper third merges into the Ripley formation; and the middle third continues into Tennessee as an impure chalk unit. In the eastern part of Alabama the part of the chalk below the Arcola limestone member merges by intertonguing into the Blufftown formation, the middle third merges into and intertongues with the Cusseta sand, and the upper part merges into the Ripley formation. The Selma and Ripley are separated from the overlying Prairie Bluff chalk by an important unconformity. The Prairie Bluff chalk merges toward the north in Mississippi into the sandy Owl Creek formation and toward the east in Alabama into the Providence sand.

The distribution of the chalks indicates deposition in clear, only moderately deep water off the southwest end of the Appalachian Highlands during much of Upper Cretaceous time; drainage from the Highlands was mainly southeast and northwest while the chalk was accumulating.

The following zones have been traced through Mississippi and Alabama: the *Exogyra ponderosa* zone, which embraces the Tombigbee sand member of the Eutaw formation and the lower two-thirds of the Selma chalk and equivalent beds; the *Diploschiza cretacea* zone, a narrow zone in the Selma chalk, within and about 200 feet below the top of the *E. ponderosa* zone, traceable from Tupelo, Mississippi, to the longitude of Montgomery, Alabama; the *Exogyra costata* zone, embracing the upper third of the Selma chalk, the Prairie Bluff chalk, and equivalent beds; the *Exogyra cancellata* zone, traceable throughout the area in the lower 200 feet or less of the *E. costata* zone.

Correlations with the Upper Cretaceous series of the western Gulf region are indicated.

INTRODUCTION

In the preparation of this paper full use has been made of all published information on the Upper Cretaceous of the eastern Gulf region in addition to the field work of the writers. The scope of this paper does not permit inclusion of a full bibliography, but lists of references will be given in official reports now in preparation.

The Upper Cretaceous sediments of the eastern Gulf region in

[1] Read before the Association at New Orleans, March 16, 1938, and published by permission of the director of the Geological Survey, United States Department of the Interior. Manuscript received, September 15, 1938.

[2] Geological Survey.

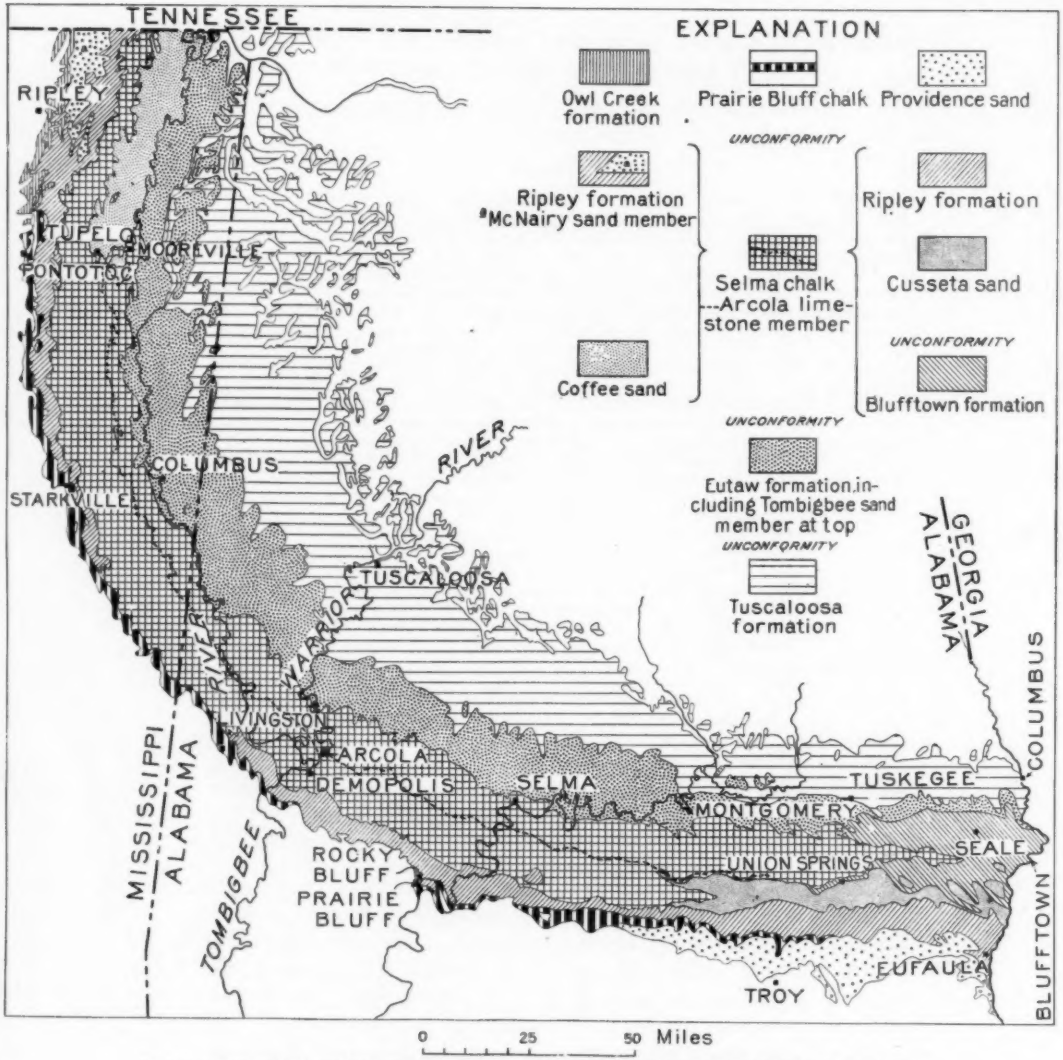


FIG. 1.—Generalized geologic map of Upper Cretaceous formations in Mississippi and Alabama.

Tennessee, Mississippi, Alabama, and Georgia appear at the surface in a great crescentic band that wraps around the southwestern end of the plunging Appalachian Highland region including the bordering Piedmont Plateau on the southeast and the Nashville uplift on the northwest. This band is 500 miles long, and centrally is 75 miles wide; the maximum thickness of the sediments is estimated to be about 2,300 feet. Sedimentation began on a peneplaned surface of pre-Paleozoic and Paleozoic rocks, and gravels, sands, and clays were deposited to form the Tuscaloosa formation; this unit is partly of nonmarine origin, but includes materials deposited in shallow marine waters, and in estuaries and lagoons. The sediments above the Tuscaloosa are of deeper marine origin except toward the ends of the crescentic band where the series is made up in part of nonmarine and in part of shallow marine sands, clays, and fine gravels.

STRATIGRAPHIC BREAKS

The deposition of the Upper Cretaceous series in the eastern Gulf region was not continuous from its inception to the end of the epoch, sedimentation having been interrupted from time to time by changes of land level or sea level, or both. These breaks in sedimentation are recorded in at least four unconformities, or disconformities, as some may please to call them, within the series. From below upward the first of the unconformities is between the Tuscaloosa formation and the overlying Eutaw formation and has been traced throughout the eastern Gulf region; it is decidedly undulating, and is easily recognizable at most places; a thin bed of rather fine gravel marks the beginning of Eutaw sedimentation. The hiatus marked by this unconformity is interpreted to include the time interval covered by the Eagle Ford shale of Texas, and the unconformity is, therefore, an important one.

The next break in sedimentation is that which separates the Tombigbee sand member of the Eutaw formation from the overlying Selma chalk; this contact is uneven in detail, and the unconformity is believed to be widespread in the area. The base of the Selma is sandy and contains many phosphatic molds of fossils, some phosphatic nodules, and shells of the oyster family, some of which were reworked from the underlying Tombigbee sand; this bed is, therefore, in the nature of a basal conglomerate.

The third stratigraphic break is about 300 feet above the base of the Selma chalk and a few feet above the Arcola limestone member. This break may be of minor time importance and probably decreases to the rank of diastem in western Alabama and in its northwestern

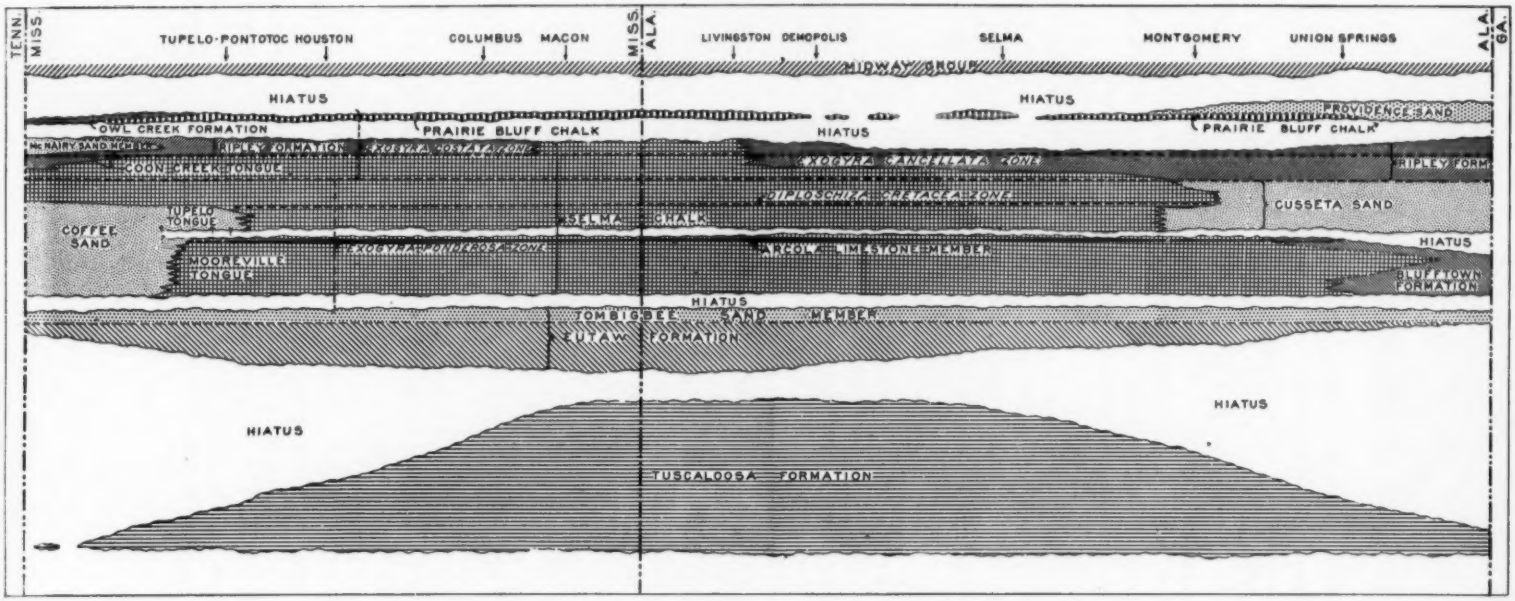


FIG. 2.—Stratigraphic and age relations of the Upper Cretaceous formations of Mississippi and Alabama.

extension in Mississippi. The position of this break is marked by a thin band of phosphatic molds of fossils, and in places by fragments of reworked limestone. The suggestion that the break may be in the nature of a diastem is based on the nearly uniform position of the contact a few feet above the Arcola limestone for a distance of more than 200 miles.

The fourth break, which separates the Selma chalk from the overlying Prairie Bluff chalk, is an important one, not only in its linear

FIG. 3.—The Tuscaloosa formation unconformably overlain by the Eutaw formation on U. S. Highway 11, 9.8 miles north of Eutaw, Alabama.

extent, but also in the long time interval that it in places represents. The basal 10 feet or so of the Prairie Bluff chalk carries a large amount of phosphatic material in the form of nodules and molds of mollusks and other organisms. This unconformity has been traced for more than 300 miles in Mississippi, Alabama, and Georgia; in places it marks a northward transgression of the Prairie Bluff chalk over a considerable thickness of older Cretaceous strata. The unconformity at the base of the Corsicana marl in Texas is interpreted to be the westward continuation of this one at the base of the Prairie Bluff chalk.

Above the Prairie Bluff chalk and separating it from the Midway group of the Eocene is an unconformity representing a major hiatus

in the succession of Coastal Plain sediments; this break has been traced throughout the length of the Atlantic and Gulf Coastal Plain and it forms everywhere a sharp separation between the Cretaceous and Tertiary systems.

SECTION IN WEST-CENTRAL ALABAMA AND EAST-CENTRAL MISSISSIPPI

The Upper Cretaceous series in west-central Alabama and in east-central Mississippi is readily divisible from below upward into four

FIG. 4.—Prairie Bluff chalk unconformably overlain by sandy clay of the Midway group in Sec. 11, T. 14 N., R. 6 E., Wilcox County, Alabama.

formational units. The Tuscaloosa formation consists of irregularly bedded gravels, sands, and clays estimated to be about 1,000 feet thick. The Eutaw formation comprises 300 feet of irregularly bedded, in part laminated, glauconitic sand and clay, grading upward into about 100 feet of massive, glauconitic sand, the Tombigbee sand member, parts of which have been indurated to form layers of calcareous sandstone and disconnected sandstone concretions. The Selma chalk includes nearly 900 feet of massive and weakly bedded chalk of greater or less purity, becoming decidedly sandy in the upper 100 feet or so; 300 feet above the base of the chalk is a thin but persistent unit, the Arcola limestone member, made up of several layers of pure limestone interbedded with chalk. (See description on pp. 1655–

1657.) At the top of the series is the Prairie Bluff chalk comprising 50 feet or less of hard chalk.

PALEOGEOGRAPHIC SIGNIFICANCE OF THE CHALK FORMATION

The distribution of chalk in the eastern Gulf region provides a key to the paleogeography of Upper Cretaceous time. As seen by the map (Fig. 1) the chalk is thickest in the western part of Alabama off the southwest end of the present Paleozoic highlands. Both toward the northwest and toward the east the chalk merges into sandy beds. This suggests that during Upper Cretaceous time after deposition of the Eutaw formation the drainage of the southeastern part of the continent of that time was mainly toward the northwest and the southeast and that few streams flowed toward the southwest. The present adjustment of drainage to structure must, therefore, have taken place during Tertiary time.

FACIES CHANGES TOWARD THE NORTH IN MISSISSIPPI

From west-central Alabama toward the north in Mississippi the formations of the Upper Cretaceous series exhibit marked changes in lithologic character and in thickness. The Tuscaloosa formation becomes progressively thinner and more gravelly until in the northeastern corner of Mississippi it is all chert gravel and in places is wanting, being overlapped by the Eutaw formation. In central Tennessee the formation is represented only by erosion remnants of gravel on the Paleozoic upland, some of them as much as 30 miles to the east of the main body of Upper Cretaceous sediments; a considerable part of the erosion which caused the northward thinning and final removal of the formation was effected during the time interval recorded in the unconformity separating the Tuscaloosa from the Eutaw formation.

The Eutaw formation, including the Tombigbee sand member at the top, extends northward across Mississippi with little change in lithologic character, but the thickness decreases by progressive overlap of the higher parts of the formation over the lower parts and even over the underlying Tuscaloosa formation until near the Tennessee state line the Tombigbee sand member rests on the basement of Paleozoic rocks. A few miles toward the north in Tennessee the Tombigbee feathers out against the Paleozoic.

The Selma chalk undergoes marked lithologic changes from south to north in Mississippi and Tennessee. The lower third of the chalk is everywhere more argillaceous than the middle third and in Lee County, Mississippi, these argillaceous beds pass by intertonguing

into the Coffee sand—a formation that resembles and was at one time included in the Eutaw formation. The Coffee, named from Coffee Landing on Tennessee River in Tennessee, consists of glauconitic, irregularly bedded sand, interbedded in places with laminated clay. A tongue of impure chalk, the Mooreville tongue, extends northward from the base of the Selma in southern Lee County, for a distance of about 20 miles, finally merging into sand. A corresponding tongue of sand, the Tupelo tongue, extends southward from the top of the Coffee sand, eventually merging into chalk. The unconformity between the Selma chalk and the underlying Tombigbee sand member of the Eutaw has been traced northward beneath the Mooreville tongue to the latitude of Tupelo. Farther north, where the Coffee sand rests on the Tombigbee sand, the contact is sharp and easily recognized, but whether the two formations are conformable in northern Mississippi has not been determined. The Coffee sand extends into Tennessee, becoming thinner in that direction until it feathers out against the basement rocks a little north of the center of the state.

The Arcola limestone member of the Selma chalk is present at the top of the Mooreville tongue and has been traced northward nearly as far as Mooreville. The unconformity or diastem above the Arcola has been traced northward to within 5 miles of Mooreville, and appears to be marked for about 15 miles still farther north within the Coffee sand by a thin bed of phosphatic nodules and molds.

The middle and purest third of the Selma chalk maintains its identity as chalk northward across Mississippi, becoming less pure, however, in that direction and becoming thinner as it passes into Tennessee; within 35 miles north of the Mississippi line this chalk disappears as such, presumably merging into sand that is indistinguishable from the Coffee sand.

In Noxubee County the upper sandy part of the Selma chalk merges northward into a prevailingly nonchalky marine sand, the Ripley formation, which extends with increasing thickness northward to and beyond the Tennessee state line; some of the sand beds are indurated and the formation includes subordinate beds of clay. In the northeastern part of Union County the middle part of the Ripley formation becomes coarser and more irregularly bedded and toward the north this shallow-water facies, the McNairy sand member, becomes progressively thicker due to the merging of both lower and higher marine beds into it. A tongue of typical marine sand and clay, the Coon Creek tongue, extends northward from the lower part of the Ripley formation, continuing as a narrow band beneath the McNairy sand entirely across Tennessee and into Kentucky. A similar

tongue extending northward above the McNairy sand thins rapidly and merges into the McNairy a few miles south of the Tennessee line.

The Prairie Bluff chalk extends in a narrow band of outcrop northward through Mississippi to the southern part of Pontotoc County where the upper part merges along the strike into the nonchalky marine sand and sandy clay of the Owl Creek formation. Toward the north in Pontotoc and Union counties successively lower parts of the Prairie Bluff merge into sand, until in southern Tippah County the

FIG. 5.—Ripley formation unconformably overlain by a sandy facies of Prairie Bluff chalk, in Sec. 8, T. 15 S., R. 4 E., Clay County, Mississippi.

entire unit is represented by the prevailingly sandy Owl Creek formation. From Tippah County the Owl Creek extends northward as a narrow band for a few miles into Tennessee, where it is completely overlapped and concealed by Eocene sediments. The buried Owl Creek formation continues northward, however, to the head of the Mississippi Embayment, where in Crowley's Ridge and in Benton Ridge in southeastern Missouri it reappears from beneath the Eocene; the Owl Creek in the latter area contains an abundant and characteristic fauna in the form of prints and molds.

The Prairie Bluff chalk rests unconformably on older underlying Cretaceous beds (Selma or Ripley) throughout its extent in Alabama and Mississippi. Farther north in Mississippi the equivalent Owl

Creek formation rests unconformably on the Ripley formation, and recently indications of an unconformity have been observed at the base of the Owl Creek in southeastern Missouri, where it rests on the McNairy sand member.

FACIES CHANGES TOWARD THE EAST IN ALABAMA

From west-central Alabama eastward certain parts of the Upper Cretaceous series undergo marked facies changes at different places along the strike, as a result of which the succession of mappable units in the Chattahoochee region and in Georgia is unlike that elsewhere in the eastern Gulf region.

The Tuscaloosa formation continues eastward essentially unchanged, but it becomes much thinner as it passes into Georgia.

The Eutaw formation extends eastward with little change in lithologic character or thickness to the longitude of Montgomery, Alabama, beyond which the lower beds of the formation are progressively overlapped by higher beds until in the latitude of Tuskegee the Tombigbee sand member rests directly on the Tuscaloosa formation, and from Tuskegee eastward only the Tombigbee is exposed. The Tombigbee sand changes from a highly glauconitic, more or less massive sand to a very fine-grained, argillaceous sand and sandy clay with interbedded more or less lenticular ledges and nodular layers of hard calcareous sandstone. A notable feature of the Tombigbee in this area is the presence of layers containing vast numbers of the shells of *Ostrea cretacea* Morton in a matrix of calcareous sand and clay. On the northeast facing slope of a branch of Uchee Creek on the road from Uchee to Marvyn, in the northwest corner of Russell County, the oyster bed attains a maximum thickness of more than 100 feet.

That part of the Selma chalk below the Arcola limestone member extends as argillaceous chalk from west-central Alabama eastward to the longitude of Union Springs, Bullock County, where it begins to intertongue with the sandy Blufftown formation. The name Blufftown was first used by Veatch,[3] the type section being the beds exposed in the lower 150 feet or so of the bluff on Chattahoochee River at the abandoned settlement of Blufftown in the northwestern part of Stewart County, Georgia. As defined in the present paper the formation includes additional beds below that were correlated with the upper part of the Eutaw formation by Veatch,[4] and with the "typical

[3] Otto Veatch, "Second Report on the Clays of Georgia," *Geol. Survey of Georgia Bull. 18* (1909), pp. 84–90, map op. p. 88.

[4] Otto Veatch, *op. cit.*, pp. 90–97.

beds of the Eutaw," by Stephenson.[5] These beds consist of irregularly bedded sands and clays, in part lignitic, and at their immediate base are coarse pebbly sands and sandstones. Traced westward these lower beds pass as a sandy tongue beneath an eastward-extending tongue of argillaceous Selma chalk, and in the longitude of Tuskegee, Macon County, the sandy beds merge into the chalk.

The tongue of impure chalk just mentioned extends eastward nearly to the longitude of Seale where it merges into calcareous clay of the Blufftown formation, and still farther east in Georgia into typical argillaceous, calcareous marine sand that has not been differentiated from the higher parts of the Blufftown. The upper part of the Blufftown formation extends westward from the Chattahoochee region as a thinning tongue of fine marine sand, in part indurated to layers of calcareous concretionary sandstone, to Union Springs, west of which it passes into the Selma chalk at about the zone of the Arcola limestone member; the concretions of one of the layers of this tongue, about 40 feet below its top, are each completely enveloped within a concentric layer, in places as much as an inch in thickness, of fine prismatic calcite crystals; these concretions constitute a useful horizon marker in eastern Alabama.

From west-central Alabama the middle, purest part of the Selma chalk (about 300 feet thick) above the unconformity that lies just above the Arcola limestone member, extends eastward with little change to and somewhat beyond Haynesville in Lowndes County, and within the next 20 miles or more passes by intertonguing with sand into the Cusseta sand of eastern Alabama and Georgia.

The typical exposures of the Cusseta sand are at and near the town of Cusseta in Chattahoochee County, Georgia. There the formation is composed mainly of cross-bedded sand ranging from coarse-grained, with scattered small quartz pebbles, through medium to fine-grained; interbedded with the sand are small to large lenses of light-colored clay. The typical Cusseta sand has the appearance of having been deposited in shallow marine water, but may be in part of lagoonal, estuarine, or even of nonmarine origin; it lies with unconformable relations on the Blufftown formation which it overlaps toward the northeast in Georgia.

In its downdip extension in Chattahoochee River valley the Cusseta sand passes into a deeper marine facies which is more or less fossiliferous. The richest fossil zone is in the basal part of the formation where more than 30 species of mollusks, several species of fish

[5] L. W. Stephenson, "Cretaceous" [of Georgia], *Geol. Survey of Georgia Bull. 26* (1911), pp. 114, 121–122.

represented by teeth, and fragmentary reptile bones, have been collected. Particularly characteristic of this zone are the shells of *Ostrea pratti* Stephenson and an undescribed species of *Ostrea* having a large, massive, elongate shell attaining a length of more than 17 inches. Within the lower 2 or 3 feet of the formation some of the oyster shells and bone fragments and accompanying phosphatic nodules are more or less waterworn, and smoothly rounded phosphatic pebbles are not uncommon. Here also are concretion-like masses of fine prismatic calcite crystals having radial structure, some of the masses attaining a long dimension of a foot or more.

In its westward continuation through Alabama the updip, nearshore facies of the Cusseta becomes a coarse sand with fine gravel lenses in its basal part. That part of the steep north-facing escarpment known as Chunnenuggee Ridge, which extends from Union Springs eastward toward Chattahoochee River, is the physiographic expression of the Cusseta sand. Near Union Springs a thin bed at the base of the formation contains the characteristic *Ostrea pratti* Stephenson and the radiated calcite masses. The merging of the Cusseta sand into the Selma chalk takes place in an east-west stretch of 15 or 20 miles in the region south of Montgomery; the intertonguing of the two formations, already mentioned, consists of two main westward-extending tongues of sand, one below and one above an eastward-extending tongue of chalk.

In west-central Alabama the upper 250 feet of the Selma chalk may be divided into a lower 100 feet of fairly pure chalk, and an upper 150 feet of sandy chalk. Traced eastward both the purer and the sandy chalk pass by merging into fine marine sand, the Ripley formation, but the change takes place farther east in the lower, purer facies than in the upper, sandy facies. The merging of the purer facies into sand takes place near the eastern boundary of Lowndes County. The overlying 150 feet of sandy chalk becomes essentially a massive marine sand in eastern Sumter County; eastward to the Lowndes-Montgomery County line the base of this sand facies (Ripley formation) remains at approximately the same stratigraphic position. The sands of the Ripley are more or less fossiliferous at most places where they have been examined.

In eastern Alabama the Ripley formation rests on the Cusseta sand. Although the presence of an unconformity separating the two formations has not been established, the lower part of the Ripley in Bullock County and in the western and central parts of Barbour County consists of coarse, cross-bedded, pebbly sand, suggesting a stratigraphic break at that position. The Ripley formation is esti-

mated to be between 300 and 400 feet thick in Chattahoochee River valley, the maximum for the formation in the Alabama-Georgia area. From Chattahoochee River the formation has been traced northeastward into Macon County, Georgia.

As previously stated, the uppermost formation of the Upper Cretaceous series in west-central Alabama is the Prairie Bluff chalk, a unit 50 feet or less in thickness. The unconformity that separates it from the underlying Selma chalk marks a hiatus of considerable

FIG. 6.—Southward-dipping beds of the Ripley formation (*Exogyra cancellata* zone) at Rocky Bluff on Alabama River, Wilcox County, Alabama.

magnitude, for in places both in Alabama and Mississippi the Prairie Bluff overlaps and cuts out Cretaceous strata below it, perhaps amounting to as much as 300 feet in thickness.

From Tombigbee River valley eastward the Prairie Bluff rests unconformably on the sands of the Ripley formation. This relationship has been observed in many exposures, the most convincing of which are those at Prairie Bluff and at Rocky Bluff on Alabama River in Wilcox County. At Rocky Bluff the lower beds of the Ripley (*Exogyra cancellata* zone, discussed below) dip downstream at an angle of approximately 4 degrees, and are overlain by the Prairie Bluff chalk whose beds have a very gentle dip scarcely greater than the gradient of the stream. At Prairie Bluff, about a mile downstream, approximately 100 feet of Ripley beds stratigraphically higher than the *Exogyra cancellata* zone dip downstream at an angle of about 2

degrees, and are overlain by the gently dipping Prairie Bluff chalk. These exposures seem to indicate pronounced structural uplift and erosion of the southward-dipping Ripley strata before they were covered by the chalky sediments of the transgressing Prairie Bluff sea. Farther east in the latitude of Montgomery nearly all of the Ripley above the *Exogyra cancellata* zone is overlapped by the Prairie Bluff chalk.

The Prairie Bluff chalk is traceable eastward as a thin, undivided unit to Lowndes County, but the continuity of its outcrop is interrupted in places by transgressive overlaps of the overlying Eocene deposits. In Lowndes County the upper part of the Prairie Bluff merges into irregularly bedded sands and clays of shallow-water marine origin, known as the Providence sand (described below). Eastward from Lowndes County successively lower parts of the Prairie Bluff merge into sandy sediments until in the longitude of Union Springs the chalk has virtually disappeared as such, and has been replaced by the sediments of the Providence type.

The Providence sand is named from spectacular exposures in deep gullies near old Providence post office in Stewart County, Georgia. The Providence has its best development on the upland in Georgia east of Chattahoochee River valley, but, as already stated, it is present also on the upland west of the Chattahoochee. Down the dip toward the south the shallower-water sands of the Providence merge into a deeper-water fossiliferous marine facies similar to that of the Owl Creek formation in northern Mississippi. These deeper marine beds are exposed in the bluffs of Chattahoochee River and its tributaries 8 to 14 miles south of Eufaula, and also in valleys farther west in Alabama. Evidence of an unconformity at the base of the marine facies of the Providence sand was observed on Whiteoak Creek 0.8 mile upstream from its junction with Chattahoochee River, on the Barbour-Henry County line, Alabama. Toward the northeast in Georgia the Providence sand overlaps and cuts out the higher beds of the underlying Ripley formation, almost down to the *Exogyra cancellata* zone.

MACROFOSSILS IN THE UPPER CRETACEOUS FORMATIONS

The Tuscaloosa formation has yielded a large number of fossil plants, mainly leaves, particularly in certain clay lenses in the lower part of the formation, but no traceable fossil-plant zones have been differentiated. On the basis of the plants the formation has been correlated with the Woodbine formation of Texas, the Raritan formation of the north Atlantic Coastal Plain, and the Cenomanian of Europe.

The only invertebrates recorded are some poorly preserved prints of *Ostrea* and *Modiolus* found near the middle of the formation at one locality in Chilton County; these and the presence of glauconite indicate the deposition of the containing bed and associated beds in shallow marine and brackish water.

Invertebrate fossils are rare in the lower part of the Eutaw formation in western Alabama and the few that have been found have not been differentiated into zones; they indicate an age younger than the Eagle Ford shale of Texas. Fossils are abundant in the upper half of the Tombigbee sand member of the Eutaw; some of them are of use as local zone markers, and some are of value in making more distant correlations. The floating crinoid species, *Marsupites americanus* Springer, is taken as indicating synchroneity with the Santonian of France, which carries the closely related *Marsupites testudinarius* Schlotheim. *Marsupites* also seems to correlate the upper part of the Tombigbee sand approximately, though perhaps not exactly, with the Telegraph Creek formation of southern Montana. *Gryphaea wratheri* Stephenson is believed to indicate the approximate synchroneity of the upper part of the Tombigbee with the *Gryphaea wratheri* zone in the upper part of the Austin chalk of Texas. The small oyster, *Ostrea cretacea* Morton, is exceedingly abundant in the Tombigbee sand in eastern Alabama.

That part of the Upper Cretaceous series which includes the upper third of the Tombigbee sand member of the Eutaw and the rest of the series above that member is divisible into two major fossil zones that have long been recognized not only in Alabama but throughout the Atlantic and Gulf Coastal Plain. In Alabama the lower of these, the *Exogyra ponderosa* zone, includes the Tombigbee sand and a little more than the lower two-thirds of the Selma chalk. The higher, the *Exogyra costata* zone, includes the upper third of the Selma and the Prairie Bluff chalk.

The lower part of the Selma chalk below the Arcola limestone member is not very fossiliferous, but its equivalent, the Blufftown formation of the Chattahoochee region, contains a large molluscan fauna that has as yet been only superficially studied; the same may be said of the equivalent of the lower Selma in northeastern Mississippi, the lower half or two-thirds of the Coffee sand, which is known to be richly fossiliferous at several places.

A narrow and persistent fossil zone in the Selma chalk about 180 feet above the Arcola limestone is characterized by the small bivalve shell, *Diploschiza cretacea* Conrad, which in places is present in considerable numbers in the zone, and by the small brachiopod, *Tere-*

bratulina filosa Conrad; the eastern terminus of this zone, as at present known, is within the tongue of chalk enclosed between the two westward-extending tongues of Cusseta sand (see p. 1650), near the middle of Montgomery County. This zone has been traced from Montgomery County to Tupelo, Mississippi, a distance of about 220 miles. The deeper marine facies of the Cusseta sand in the Chattahoochee region, which is the age equivalent of the middle part of the Selma above the Arcola member, has yielded a rich molluscan fauna from its lower part.

The correlative of the *Diploschiza* zone in Texas is characterized by the varietal form *Diploschiza cretacea minor* Stephenson and by *Terebratulina filosa* Conrad. These species are present in a narrow zone near the top of the Annona chalk in northeastern Texas, in the Pecan Gap chalk member of the Taylor marl in east-central Texas, and in the upper part of the Anacacho limestone in Medina County west of San Antonio.

In west-central Alabama the dividing line between the zones of *Exogyra ponderosa* and *Exogyra costata* lies about 150 feet above the *Diploschiza cretacea* zone. Immediately above this line is the *Exogyra cancellata* zone, about 150 feet thick, which is important because of its persistence at this stratigraphic position not only in the eastern Gulf region, but throughout the Atlantic and Gulf Coastal Plain; *E. cancellata* has also been found at two localities in the State of San Luis Potosi, Mexico, 400 miles south of the Rio Grande. Associated with *E. cancellata* at many places in this zone in the United States is the bivalve *Anomia tellinoides* Morton, a species that has never been found either above or below this zone. The classic fossil locality discovered by Bruce Wade in the Coon Creek tongue of the Ripley formation in northeastern McNairy County, Tennessee, is in the upper part of the *E. cancellata* zone.

The upper sandy part of the Selma chalk above the *E. cancellata* zone is not very fossiliferous but the Ripley formation, which is the nonchalky facies of this part of the section in northern Mississippi and in the Chattahoochee region, contains large and varied faunas in some of its beds. The types of a goodly number of well known Ripley species were obtained from exposures on and near Chattahoochee River from the vicinity of Eufaula downstream for 8 or 10 miles. The faunas of the Ripley formation in Mississippi and Alabama have been only superficially studied and many of their included species are yet to be described.

The lower part of the Prairie Bluff chalk carries a rich fauna much of which is in the form of internal phosphatic molds. The bivalve ***Diploschiza melleni*** Stephenson is a restricted and characteristic

species; the small bivalve *Crenella serica* Conrad is abundant but not restricted as it is occasionally found as low as the *Exogyra cancellata* zone; a varietal form of *Exogyra costata* Say with narrow costae is abundant; the small bivalve *Pecten venustus* Morton is common but is occasionally found at lower positions in the *Exogyra costata* zone; several species of ammonites, including *Scaphites*, *Baculites*, and *Sphenodiscus*, are common and these, together with several species in other groups, suggest correlation with the Corsicana marl of Texas. Several species of foraminifera, notably *Siphogenerinoides plummeri* Cushman from the upper part of the Prairie Bluff chalk, are interpreted by J. A. Cushman and Helen Jeanne Plummer to indicate synchroneity with the upper part of the Kemp clay of Texas. No unconformity has been recognized in the Prairie Bluff; on the assumption, therefore, that this foraminifer is as limited in vertical range as it is supposed to be, it indicates that the 50 feet or so of this chalk was deposited during the time interval of the deposition of the 400 feet or more of the combined Corsicana marl and Kemp clay in Texas.

The Owl Creek formation, the equivalent in northern Mississippi of the Prairie Bluff chalk, is rich in well preserved fossils, chiefly mollusks, only partly described, some of which are restricted in vertical range to this unit. The classic exposures on Owl Creek northeast of Ripley in Tippah County furnished the 57 species described by Conrad in 1858. Scarcely less rich are the fossil-bearing beds of the deeper marine facies of the Providence sand, which is the equivalent in the Chattahoochee region of the Prairie Bluff chalk.

DESCRIPTION OF THE ARCOLA LIMESTONE MEMBER OF THE SELMA CHALK

About 300 feet above the base of the Selma chalk in Alabama is a thin but persistent unit consisting of layers of pure hard limestone, interbedded with chalk, which has been traced from Bullock County westward through Alabama and northward through Mississippi nearly to Mooreville in Lee County, a distance of 250 miles. This limestone was recognized and described in Sumter and Hale counties by E. A. Smith and his associates.[6] This unit is here named the Arcola limestone member of the Selma chalk, from its type exposure in the bluff at old Arcola Landing on Warrior River (NE. $\frac{1}{4}$, Sec. 4, T. 18 N., R. 3 E., Hale County), about 5 miles (air line) northeast of Demopolis, Alabama. The section at Arcola Landing, as described by the junior writer, is given here.

[6] E. A. Smith, L. C. Johnson, and D. W. Langdon, Jr., "Report on the Geology of the Coastal Plain of Alabama," *Geological Survey of Alabama*, Montgomery (1894), pp. 279, 539, 605.

FIG. 7.—Type section of the Arcola limestone member of the Selma, old Arcola Landing on Warrior River, Hale County, Alabama: (a) bed 3a (see described section); (b) bed 3c; (c) bed 5. The unconformity interpreted to be at the top of bed 3c can not be distinguished in the photograph.

Section at Arcola Landing, Warrior River

Selma chalk	*Feet*
6. Brownish gray shaly chalk containing scattered phosphatic nodules	6
5. Chalk containing abundant phosphatic nodules, phosphatic molds of mollusks, and blocks of limestone up to 10 inches in length, derived by reworking from an underlying bed of limestone	1
4. Hard gray shaly chalk containing scattered phosphatic nodules	2
Unconformity or diastem (somewhat irregular)	
3. Arcola limestone member	
c. Hard limestone perforated with chalk-filled borings (bored rock)	1
b. Light gray hard shaly chalk	2
a. Hard limestone perforated with chalk-filled borings; possibly a thin chalk layer in the middle of the bed	2
2. Hard light blue-gray chalk with several interbedded shaly layers	12
1. Concealed by muddy sediment to water level* (April 28, 1938)	3
Total	29

* This section was described during a period of high water. The river stage at Demopolis on April 28 was 42.2 feet; during normal low water of the fall months the stage is 12 or 13 feet.

The Arcola limestone member is well exposed at normal low water above 40 feet of Selma chalk in the upper part of Hatchs Bluff on Warrior River, about a mile east of Arcola. In Mississippi a phosphatic bed a few feet above the Arcola limestone, and presumably marking the same stratigraphic break as that at Arcola Landing, and

elsewhere in Alabama, has been traced nearly to Mooreville, Lee County, where, however, only a single bed of limestone has been seen below it. Toward the east in Alabama additional layers of limestone have been observed beneath the unconformity, as many as four having been counted in a thickness of 15 feet, on State Highway 22, near Beloit in Dallas County. The Arcola member has been seen here and there along its outcrop as far east as Bullock County where at one place three limestone layers were noted. The Arcola limestone corresponds in age to the upper part of the Blufftown formation of eastern Alabama and Georgia. The unconformity above the Arcola has been traced eastward into Georgia where it separates the Blufftown from the overlying Cusseta sand.

FIG. 8.—Characteristic mesa-like hill capped by two layers of Arcola limestone, just north of U. S. Highway 80, 1.1 miles west of Browns, Dallas County, Alabama.

The limestone layers of the Arcola member after they became partly consolidated were bored by bottom-living organisms, perhaps crustaceans, and the borings became filled with softer chalky oozes from above; upon weathering the softer filling is removed, giving to the rock a perforated appearance, and it is sometimes locally called "bored rock." Along its line of outcrop this "bored rock" caps small mesa-like hills (Fig. 8) and forms the top of a low cuesta with its shorter slope forming a landward-facing scarp—facing east near Aberdeen, Mississippi, and north in central Alabama. The cuesta has resulted from the differential weathering of the comparatively soft Selma chalk and the hard limestone. The limestone has been found to have local value as a roadmetal in parts of Hale County, Alabama, where gravel deposits are wanting. The rock is scraped from the tops of low hills on which there is no overburden and, after crushing, is hauled to distances of 10 miles or more from its source.

BULLETIN OF THE AMERICAN ASSOCIATION OF PETROLEUM GEOLOGISTS
VOL. 22, NO. 12 (DECEMBER, 1938), PP. 1658-1681, 5 FIGS.

GEOLOGY OF BELLEVUE OIL FIELD, BOSSIER PARISH, LOUISIANA[1]

A. F. CRIDER[2]
Shreveport, Louisiana

ABSTRACT

The Bellevue oil field is in T. 19 N., R. 11 W., Bossier Parish, in the midst of the oil- and gas-producing area of northwestern Louisiana.

Although the presence of a structure was long suspected from surface geology, the field was discovered in 1921 by a systematic plan of core drilling which located the crest of the uplift and proved it as an oil field.

Geologically, Bellevue is probably a deep-seated salt dome in which salt has forced the overlying formations as much as 2,000 feet above their normal horizontal position. The deepest well on the structure is Harry Morgan's Smith No. 2, completed at a depth of 6,147 feet without encountering salt.

Bellevue is one of the outstanding shallow fields of northern Louisiana. The oil is produced from the Nacatoch sand at the shallow depth of 300–400 feet, with some gas and oil from the contact of the Upper and Lower Cretaceous at a depth of about 1,800 feet.

The economy of drilling to such a shallow depth and the prolific nature of the Nacatoch sand has made Bellevue approach the Utopia of the oil man's dream. On January 1, 1938, the field had produced a total of 9,860,430 barrels of oil from 900 acres, or an average of 10,996 barrels per acre, and for the year 1937, the field produced 280,130 barrels

Depression conditions caused the field to be closed during the years 1932 and 1933. All wells were abandoned and casing was pulled from many of them. Production for the year previous to the shut-down, 1931, was 103,930 barrels and for the year 1937, with only a part of the field reworked, it had reached a total of 280,130 barrels. A re-drilling of one 80-acre tract, which was abandoned with casing pulled in 1932, to January 1, 1938, resulted in a total new production of 3,000 barrels per acre.

LOCATION

The Bellevue oil field is in T. 19 N., R. 11 W., Bossier Parish, Louisiana. The present limits of the producing area include parts of Secs. 10, 11, 14, 15, 22, 23, 26, and 27. It is surrounded by producing oil fields of northern Louisiana with the Homer oil field 24 miles east, the Cotton Valley field 12 miles northeast, the Sligo gas field 7 miles southwest, the Dubberly gas field 9 miles southeast, and the Pine Island field 30 miles northwest.

The field is named from the old village of Bellevue, the first Parish seat of Bossier Parish.

Previous to and during its development the field was almost inaccessible during the rainy season, but now can be reached by good gravel roads which give an outlet for some of the oil which is hauled by truck to a railroad loading rack at Princeton.

[1] Read by title before the Association at New Orleans, March 18, 1938. Manuscript received, July 16, 1938.

[2] Consulting geologist, 1212 City Bank Building.

HISTORY

The first geologic reference to the Bellevue area was made by L. C. Johnson[3] in 1888, who recognized older Tertiary formations surrounded by younger beds. In 1906 A. C. Veatch[4] mapped undifferentiated Eocene as a hill surrounded by Pleistocene deposits. In 1909 G. D. Harris[5] mapped the area very much as Veatch had mapped it. In 1923 Holman and Campbell[6] published an article describing the development of the field to that time.

The first comprehensive report of the field was made by L. P. Teas[7] after the producing area had been largely developed and the outlines of production defined.

The first evidence that any oil had accumulated in this uplift was found in the Standard Oil Company's Heilperin No. 1, Sec. 32, T. 20 N., R. 11 W., where in 1922 some dead oil was encountered at several horizons. This well was later found to be far down the north flank of the structure. The presence of oil in the Heilperin well and the fact that the formations in this well were structurally higher than in the surrounding wells led to later development by R. O. Roy and others and the final discovery of the field. The Standard well was drilled on the advice of S. C. Stathers, chief geologist of the Standard Oil Company of Louisiana.

In 1919, J. Y. Snyder, an independent geologist of Shreveport, R. O. Roy, and others began a series of core tests to locate, if possible, the top of the structure and after ten wells were drilled the outline of the uplift was determined and the first producing well was completed on November 13, 1921, from the Nacatoch sand at a depth of 398 feet. The Louisiana Oil Refining Corporation, the Standard Oil Company of Louisiana, the Humble Oil and Refining Company, R. L. Autrey, George Wetherbee, and others shared in the rapid development of the field which, on account of the shallow depth of the sand and the great demand for the oil as a lubricant and for its by-products, became one of the most profitable oil fields, for the money invested, of any in Louisiana.

[3] L. C. Johnson, "Report on the Iron Regions of North Louisiana and East Texas," *Ex. Doc. 195, 50th Congress* (1888).

[4] A. C. Veatch, "Geology and Underground Water Resources of Northern Louisiana and Southern Arkansas," *U. S. Geol. Survey Prof. Paper 46* (1906).

[5] G. D. Harris, "Oil and Gas in Louisiana, with a Brief Summary of Their Occurrence in Other States," *U. S. Geol. Survey Bull. 429* (1910).

[6] E. Holman and R. B. Campbell, "The Bellevue Oil Field, Louisiana," *Bull. Amer. Assoc. Petrol. Geol.*, Vol. 7, No. 6 (November-December, 1923), pp. 645–52.

[7] L. P. Teas, "Bellevue Oil Field, Bossier Parish, Louisiana," *Typical American Oil Fields*, Vol. 2 (Amer. Assoc. Petrol. Geol., 1929), pp. 229–53.

In the development of the field, the Nacatoch sand has been the chief source of production although oil was present in the "Woodbine sand" in the Standard Oil Company's Heilperin No. 1 from depths of 2,503 to 2,509 feet and in R. O. Roy's Smith No. 1, Sec. 7, T. 19 N., R. 11 W., from a depth of 2,173 feet. Other deep tests failed to find oil in paying quantities in the Lower Cretaceous formations and after the completion of the Humble Oil and Refining Company's Bliss and Wetherbee No. 30, in 1927, near the center of Sec. 15, T. 19 N., R. 11 W., to a depth of 5,302 feet, as a dry hole, it was the general opinion of those holding leases in the field that there was little prospect of finding production in the lower formations and a large part of the area, except that held by production, was released to the land owners.

In the early part of 1930, H. I. Morgan, an independent operator of Shreveport, thinking the deeper possibilities of Bellevue had not been thoroughly tested, began a systematic search for oil in the Lower Cretaceous and from the early part of 1930 to the latter part of 1933, he completed twelve wells all of which were drilled to test the possibilities of the Lower Cretaceous horizons. Eight of these wells were drilled in Section 22, three in Section 21, and one in Section 28. The last well drilled was Smith No. 2 in Section 22 which was completed at a depth of 6,147 feet and, up to that time, it was the deepest test, stratigraphically, of any well in the state.

Morgan's Kendrick No. 1, Section 22, was completed as a gas well from a depth of 1,786 feet with an initial production of 38,448,000 cubic feet of gas.

Morgan's Kendrick No. 2, Section 22, was completed as an oil well with an initial production of 300 barrels of oil and salt water, from a depth of 1,800 feet.

Morgan's Kendrick B-13, also in Section 22, was completed as a gas well with an initial production of 20 million cubic feet of gas from a depth of 1,764 feet.

Morgan's Kendrick B-11, Section 22, had an initial production of 27,147,000 cubic feet of gas from a depth of 1,841 feet.

Morgan's Smith No. 1, Section 22, was completed as a gas well with a daily production of 16,800 cubic feet of gas from a depth of 1,770 feet.

All of these wells drilled by Morgan had their production from the contact of the Upper and Lower Cretaceous. The other seven wells drilled by him were completed as dry holes.

Since the discovery of oil and gas in the Bodcaw sand at Cotton Valley and the still deeper zones in Schuler and Buckner, Arkansas, there has been a renewed interest in the Bellevue field and the Premier

Investment Company of Fort Worth, Texas, with Kenneth L. Wickett as president, has leased a large part of the structure and will drill one deep well or more to test the possibilities of the deep Cotton Valley, Schuler, and Buckner zones.

TOPOGRAPHY

The Bellevue field is in a low topographic basin between Bodcaw Bayou on the west and Bayou Dorcheat on the east. The terrane is fairly level, with an elevation of approximately 210 feet above sea-level with a rim of higher hills which partly encircle the field. The surrounding hills rise to an elevation of 200 feet or more above the enclosed topographic erosional basin. In the central part of the area erosion was at first rapid due to the great amount of surface uplift and it continued until the soft Midway shale was reached. After about half of the thickness of the Midway was removed, erosion was largely checked as a result of the area having reached the level of the old Pleistocene terrace which has an elevation in this region of about 220 feet.

HISTORICAL GEOLOGY

In Union County, Arkansas, several deep wells have been drilled, and in one, after the full thickness of the sedimentary rocks was penetrated, the bit entered rock salt. The Gulf Refining Company's Lewis Werner Saw Mill Company No. 49, Sec. 5, T. 16 S., R. 16 W., drilled the full thickness of the rock salt and, 485 feet below the base of the salt, entered black igneous rock at a total depth of 7,973 feet.

R. W. Norton's J. E. Payne No. 1, Sec. 27, T. 23 N., R. 16 W., Rodessa field, Louisiana, drilled through 11,470 feet of sedimentary rocks and 18 feet into rock salt where the well was plugged back to the Rodessa zone where it was completed as a gas well.

In north-central Louisiana several shallow salt domes have been discovered where rock salt is within a few feet of the surface. The deepest well to encounter rock salt on a so-called "salt plug" was the Ohio Oil Company's Z. R. Rolen No. 2, Sec. 5, T. 12 N., R. 1 W., Winn Parish, Louisiana, where the salt was encountered at a depth of 4,931 feet.

In addition to the known salt domes, there are, in southern Arkansas and northern Louisiana, several oil and gas fields, the outlines and limited areas of which indicate the presence of deeply buried salt plugs where the salt has never actually been found.

The presence of uplifted salt plugs underlying the greater number of the oil and gas fields of northern Louisiana and southern Arkansas

is further suspected from results of geophysical work in this general area. Bellevue, Homer, Haynesville, Sugar Creek, Lisbon, Sligo, Elm Grove, Bethany, Pine Island, and other more recently discovered gas fields probably originated in the upward movement of salt.

Bellevue is one of the outstanding examples of these typically reflected, deeply buried, producing domes where rock salt is suspected to form the core of the uplift.

The geologic history, which made possible such domes as the Bellevue field, is of interest for the full understanding of the accumulation of oil and gas in such structures.

Following the deposition of the Paleozoic sediments and the subsequent uplift, there was a long period of erosion and removal of much of the Paleozoic section resulting in bringing all that part of northern Louisiana and southern Arkansas to base level. This period was followed by one of downwarping and submergence, and the old eroded surface of the Paleozoic sea floor received new deposits of rock salt, anhydrite, limestone of pre-Comanche and still later sediments of Comanche age. This deposition continued without any great major interruption throughout Comanche time in which more red beds, anhydrite, limestone, shale, and sand were laid down.

After Comanche sedimentation, and before Upper Cretaceous deposition began, there was a regional upwarping, a southward retreat of the sea from this general region, and the growth of the interior salt domes and the development of the Sabine and Washita uplifts. At the close of this period of uplift either Bellevue stood as a sharp hill towering above the surrounding territory or erosion kept pace with the uplift and before the submergence and encroachment of the Upper Cretaceous sea the entire thickness of the Washita, the upper Glen Rose, the anhydrite section of the middle Glen Rose, and part of the lower Glen Rose sediments were eroded from its crest.

Submergence followed and on the beveled edges of the Comanche rocks the Upper Cretaceous deposition of Tokio, Brownstown, Ozan, "Chalk," Nacatoch, and Arkadelphia sediments followed with little interruption.

The sedimentary break between the Cretaceous and the Tertiary has long been known but in some localities it is distinguishable only by the sudden break in fauna. In the Richland gas field the entire Upper Cretaceous section has been removed by erosion and Midway rocks rest on those of Comanche age. In Bellevue the upper part of the Comanche rocks was removed by erosion and the Tokio sediments of Upper Cretaceous rocks rest on oölitic limestone of lower Glen Rose age.

After the Upper Cretaceous and the Tertiary deposition was ended, the Bellevue region was subjected to a final upwarping which brought it above sea-level and the growing salt plug bent the older and already highly folded rocks, along the old lines of weakness, into still sharper folds and the later sediments into more gentle folds. Subsequent erosion left the truncated Tertiary rocks encircling the older sediments as an inlier. The contour map (Fig. 1) shows the nature of the folding on top of the Nacatoch formation.

STRATIGRAPHY

The oldest formation which immediately underlies Pleistocene and Recent in the Bellevue field proper is shale of Midway age. It underlies all of the central basin from which rocks of Wilcox and Claiborne age have been removed by erosion. The unweathered shale is black to dark gray in color and weathers to dark soil. On the east side of the field the residual Midway soil is a treeless prairie covered with a native grass quite different from any grass in that part of Louisiana. It was probably this grass-covered prairie surrounded by dense forest that led the geologists to the discovery of the uplift. Drab to reddish shale and sand of Wilcox age immediately encircle the Bellevue dome and still farther out are overlying younger Claiborne rocks. Without the influence of the Bellevue uplift the normal northeast dip, from the center of the Sabine uplift, would have carried the Wilcox sediments beneath basal Claiborne rocks 6 miles or more southwest of the Bellevue field. It is this abnormal position of the Wilcox and the older beds which crop out as an inlier that gives the surface evidence of an uplift, the magnitude of which was only partly realized until the drill discovered the Nacatoch sand at the shallow depth of 300 feet, which sand, without the uplift, would normally be found at a depth of 1,500 feet.

Red, ferruginous, green, sandy marl of Cane River age crops out at the old village of Bellevue. In the southeast corner of Sec. 5, T. 19 N., R. 11 W., and in the southwest side of the field in Sections 32 and 33, between Princeton and Fillmore, and along Highway 80 from the west side of Giddens Castle east to Clarks Bayou, beds of Cane River age crop out. These Cane River beds of clay interbedded with glauconitic sand weather to deep red clay soil and indurated sandstone. The Cane River is fossiliferous in places.

SUBSURFACE STRATIGRAPHY

Table I shows the formations below the surface as revealed by the drill bit. The section gives the average thickness of the formations

near the crest of the uplift and does not apply to thicknesses off the flanks of the dome.

TABLE I

GEOLOGIC FORMATIONS, BELLEVUE FIELD

System	*Series*	*Group*	*Formation*	*Thickness in Feet*	*Lithology*
Quaternary	Recent			Thin	Alluvial sand and clay
Tertiary	Eocene		Midway clay	100	Non-calcareous gray to black clay with siderite boulders in upper part and fossiliferous in lower part
.....	.....	*Unconformity*	.....	.....	.....
		Navarro	Arkadelphia clay	40	Dark gray marine clay and limestone, fossiliferous throughout
			Nacatoch sand	300 to 350	Marine shale, sand, and limestone. Principal source of oil
	Gulf (Upper Cretaceous)	Taylor	Saratoga chalk	100	Light gray fossiliferous clay
			Marlbrook	120	Dark gray fossiliferous marl and clay
			Annona chalk	110	White chalk, poorly fossiliferous
			Ozan	170	Dark gray, micaceous clay, calcareous clay, and chalk
Cretaceous			Buckrange sand	10	Pebbly, quartz sand source of oil in near-by fields, but poorly developed here
		Austin	Brownstown-Tokio	700	Fossiliferous, dark gray shale, sand with small amount of glauconite, micaceous mudstone, lower part contains red beds, bentonitic clay and sand
	.....	*Unconformity*	.....	.....	.....
			Upper Glen Rose	0 to 480	Limestone, sand, containing oil and gas, all eroded from top of dome
	Comanche (Lower Cretaceous)	Trinity	Anhydrite	0 to 410	Anhydrite, limestone, shale, eroded from top of dome

TABLE I—*Continued*

System	*Series*	*Group*	*Formation*	*Thickness in Feet*	*Lithology*
Cretaceous	Comanche	Trinity	Lower Glen Rose	1,100 to 1,150	Oölitic limestone, shale, and sand containing oil and gas
		?	Pine Island (Travis Peak)	1,850 to 1,860	Largely non-marine shale, siltstone, and sand of characteristic red, green, and chocolate color
		?	Cotton Valley	1,429 feet penetrated	Black marine shale and limestone. Bodcaw sand of Cotton Valley occurs about 480 feet below top of Cotton Valley formation

COTTON VALLEY FORMATION

The oldest formation reached to date in the Bellevue field is black marine shale and limestone here designated as the Cotton Valley formation. In the upper part of the formation, in the Cotton Valley field, occur five or more beds of quartz sand which, in Cotton Valley and perhaps in the Schuler field of Arkansas, are productive of oil and gas. The Bodcaw sand is part of the Cotton Valley formation and is the producing zone in Cotton Valley from a depth of 8,100 feet to 8,600 feet.

"Cotton Valley" formation is the name the Shreveport Geological Society's committee on nomenclature has proposed for the black shale, limestone, and associated sand beds immediately overlain in northwestern Louisiana by the present so-called "Pine Island" formation and the lower limits of which are at present undeterminable. In Arkansas, the Cotton Valley formation is represented by red beds which are the updip time equivalent of the black shale, limestone, and sand of northwestern Louisiana.

Another explanation for the Cotton Valley formation is to consider it as a lenticular formation of marine origin formed in offshore seas while the more clastic deposits of red sand and clay were forming nearer the strandline.

The Cotton Valley formation does not occur at the surface but was discovered in the Humble Oil and Refining Company's Bliss and Wetherbee No. 30, Sec. 15, T. 19 N., R. 11 W., in the Bellevue field. The top of the formation in this well is placed, by the writer, at a

depth of 4,972 feet; the well was completed in the "upper Bodcaw" sand of the Cotton Valley formation at a depth of 5,302 feet.

PINE ISLAND

Travis Peak is the name assigned by Hill[8] to certain beds of Comanche age underlying the Glen Rose in Travis County, Texas. The Travis Peak at the type locality is described as red in color and profusely fossiliferous.

Spooner[9] used the term "Travis Peak" for certain red, purple, and green sands, shale, and limestones underlying the lower Glen Rose and above the Neocomian and placed the age of these beds as Comanche.

In the Prairie River Syndicate's Hutchinson No. 1, Sec. 15, T. 15 N., R. 12 W., Caddo Parish, fossil-bearing cores from a depth of 5,350–5,380 feet were submitted by the writer to Imlay and Kellum, of the University of Michigan, who recognized a species of *Paraphorites* which they refer in age to upper Aptian or Travis Peak. These fossils occur in chocolate-brown calcareous shale and limestone 490 feet above the typical red sand and shale heretofore regarded as Travis Peak.

From 6,058 feet to 6,490 feet core samples from the same well were submitted to the same authorities and Kellum found certain pelecypods which he thinks may be Neocomian or possibly Jurassic in age. These pelecypods occur in the heart of the red-bed section of so-called "Travis Peak," and should additional fossiliferous evidence prove these red beds, which are below the lower Glen Rose in Louisiana, to be Jurassic in age, then the name "Travis Peak," as now used, will no longer be applicable for Arkansas and Louisiana. Additional evidence of the Jurassic hypothesis is the presence of pink anhydrite in the Prairie River Syndicate's Hutchinson well No. 1, Sec. 15, T. 15 N., R. 12 W., near Caspiana, Caddo Parish, at a depth of 6,638 feet, intercalated with the red beds.

The red, purple, and greenish shale, siltstone, and sand, with thin beds of calcareous shale and limestone, a part of which is fossiliferous in character, underlying the lower Glen Rose, make up what is here called the "Pine Island" formation. This great thickness of red beds was first completely penetrated in the Dixie Oil Company's Dillon

[8] Robert T. Hill, "Geology and Geography of the Black and Grand Prairies, Texas, with Detailed Descriptions of the Cretaceous Formations and Special Reference to Artesian Waters," *U. S. Geol. Survey 21st Ann. Rept., 1899–1900*, Pt. VII (1901), p. 131.

[9] W. C. Spooner, "Oil and Gas Geology of the Coastal Plain in Arkansas," *Arkansas Geol. Survey Bull. 2* (1935).

No. 92, Sec. 13, T. 21 N., R. 15 W., Pine Island field, Caddo Parish, from a depth of 3,897–5,919 feet.

In the Bellevue field the Pine Island formation comprises mottled red, green, and purple sand, siltstone, and shale. The top of the Pine Island formation in H. I. Morgan's Smith No. 2, Sec. 21, T. 19 N., R. 11 W., was encountered at a depth of 2,510 feet and the base was at 4,718 feet. The Pine Island formation is underlain by the Cotton Valley formation.

LOWER GLEN ROSE

Much of the limestone from the base of the anhydrite to the top of the underlying Pine Island red beds is oölitic. Some of the oölites, like those found in the Pine Island field, are as large as 0.1 inch in diameter. Generally, however, the oölites are no larger than small rounded sand grains. Associated with the oölitic limestone are coquina limestone and more or less calcareous shale. The coquina and oölitic zones for approximately 400 feet below the lower anhydrite stringer in Rodessa are the oil and gas reservoirs.

In the upper part of the lower Glen Rose 100 feet or more of red beds are recognized at Sugar Creek, Rodessa, and other fields where the formation has been cored in detail.

In the Rodessa field below the anhydrite, there are four separate oil and gas zones, with a total thickness of approximately 400 feet. These are named in order from the base upward as the Young, the Dees, the Gloyd, and the Hill.

The four producing zones at Rodessa may be too tight to produce in other areas or the entire zone may be limited to one porous zone.

In Bellevue the basal Tokio rests unconformably on one of the oölitic beds or on the intervening shale and limestone of the upper part of the lower Glen Rose. The uppermost beds have been eroded from the crest but are found in wells on the flanks of the uplift. For some distance downdip there is the possibility of oil and gas accumulation in the eroded, lenticular lower Glen Rose limestones.

The lower Glen Rose is represented in the center of the Bellevue field by about 800 feet of hard limestone, shale, and some sand.

ANHYDRITE ZONE

White anhydrite and interbedded calcareous shale and dense, buff, silty limestone, make up the middle Glen Rose. There are no distinguishing fossils to separate the upper from the lower Glen Rose. The separation is made solely on the basis of anhydrite occurrence, which is not an infallible guide as there are stringers of anhydrite

below the oölitic limestone which is correlated as "lower Glen Rose."

In a normal section, the anhydrite is separable into three divisions. These are the "massive anhydrite," with one or more "upper stringers" and one and in some places two "lower stringers." In places the upper stringer is not present and in other localities the lower stringers are both absent. In the top of the Bellevue dome the entire anhydrite section has been eroded but is present in the flank wells.

UPPER GLEN ROSE

The Glen Rose has long been recognized in Louisiana from the first deep tests drilled in the Pine Island field where cores and cuttings from 2,400 feet to 4,000 feet contained milliolids, oölites, and *Orbitulina texana*, characteristic Glen Rose fossils.

Fossils collected from the section above the anhydrite were called "upper Glen Rose" in age and the same fossils from below the anhydrite were designated "lower Glen Rose." The formation thus became easily divisible into three parts, the anhydrite zone, a zone above and a zone below the anhydrite.

The upper Glen Rose is made up of dense, light gray, fossiliferous limestone, pseudo-oölitic in character, and steel-gray to white oölitic limestone with dark gray oölites and gray shale interspersed in places with sand and sandy shale. In the center of the Bellevue field the Washita-Fredericksburg, the Paluxy red beds, all of the upper Glen Rose, and the middle Glen Rose have been eroded, but a part of the formation, particularly the anhydrite, is present in the Standard Oil Company's Elige Moory well in the center of Section 28, in The Texas Company's Scanlan well in Section 29, in Morgan's Wetherbee No. 2 in the northeast quarter of Section 28, in the Premier Investment Company's McDade No. 1 in the northeast quarter of Section 28, and in Morgan's Wetherbee Nos. 3 and 4 in Section 21, all on the southwest edge of the dome.

BROWNSTOWN-TOKIO

The Tokio and overlying Brownstown marl of the Bellevue field are not easily separable into two formations and are here treated as one formation. The combined thickness of the two formations is approximately 700 feet. The lower 50–75 feet overlying the Glen Rose is a bentonitic clay interbedded with sand and thin limestone beds. Sticky shale, blackish gray in color, and sandy shale comprise the next 300 feet above with an increase in sand content. The upper part, which is referable to the Brownstown, is grayish brown, calcareous shale, and light gray, fine-grained, glauconitic, calcareous sandstone with micaceous silty shale. The lower division, which is

Tokio in age, contains greenish gray, medium fine-grained, chloritic, glauconitic, argillaceous sandstone, with small carbonized plant remains and white ashy material. Gray, micaceous calcareous shale with fine-grained glauconitic and biotitic calcareous sandstone and calcareous shale are present near the base of the Tokio.

BUCKRANGE SAND

Separating the Brownstown below from the Ozan above is a body of fairly fine-grained to medium fine-grained, grading into subrounded coarse-grained sand of widespread deposition in northern Louisiana and southern Arkansas that generally contains glauconite and small, dark, water-worn pebbles. This sand member, which in places is broken into a series of interbedded, gray, calcareous shale and sandy clays, was given the name "Buckrange sand" by Dane.[10] It is from this zone that oil and gas have been produced in Haynesville, Shongaloo, Cotton Valley, Sarepta, and Homer. In Bellevue it contains salt water even on the highest parts of the structure and, in many wells, it is logged as sandy shale. Where accurately logged, it is 10–20 feet in thickness.

OZAN

Immediately above the Buckrange sand and below the Annona chalk is gray, calcareous, finely micaceous shale or marly shale which, in Bellevue, has a thickness of about 170–185 feet.

ANNONA CHALK

The Annona chalk in the center of the Bellevue uplift is rather hard white granular or silty chalk sparingly fossiliferous throughout. It is the equivalent of the Selma chalk of Mississippi and Alabama and of the Taylor or Pecan Gap of Texas. The thickness ranges from 100 to 150 feet on the crest of the Bellevue structure to more than 400 feet in near-by areas.

MARLBROOK

Between the overlying Saratoga and the underlying Annona chalk is another marine member of light gray, fossiliferous, chalky marl that is not easily separated from the other two formations without cores and good well samples. This middle member has been named by Veatch,[11] and redefined by Dane,[12] as the Marlbrook. The thickness in the Bellevue field is about 120 feet.

[10] Carle H. Dane, "Upper Cretaceous Formations of Southwestern Arkansas," *Arkansas Geol. Survey Bull. 1* (1929).

[11] A. C. Veatch, *op. cit.*

[12] Carle H. Dane, *op. cit.*

SARATOGA CHALK

The Saratoga is a marine formation of light, grayish white, glauconitic, fossiliferous, silty chalk with a thickness in the Bellevue field of approximately 100 feet. It lies above the Marlbrook and below the Nacatoch.

NACATOCH FORMATION

The Nacatoch formation is not of uniform character and thickness throughout the Bellevue field. North of the central part of the field it consists of about 150 feet of calcareous sandstone and fossiliferous, finely glauconitic, sandy limestone in the upper part, separated by 10–20 feet of shale near the center and about 150–200 feet of shale, sandy shale, and limestone below. It is from the upper sands that oil is produced in the Bellevue field.

In the early development of the field, it was the custom to drill the first 10–20 feet of sand. Later the Premier Investment Company of Fort Worth, Texas, took over some abandoned leases in the field and, on the Wyche lease in the NW. ¼ of Sec. 14, T. 19 N., R. 11 W., found 110–150 feet of producing Nacatoch sand with 10–15 feet of shale separating the upper from the lower zone. The lower section of the Nacatoch sand on the Wyche lease had never been drained. A detailed log of the upper formations and the Nacatoch producing zone is shown in Table II. The top of the Nacatoch is at 257 feet.

TABLE II

LOG OF PREMIER INVESTMENT COMPANY'S WYCHE NO. 40, SEC. 14, T. 19 N., R. 11 W.
Elevation, 203.1 feet. Drilled in May, 1937

Formation		*Feet*
Soil		3
Clay		25
Sandstone		32
Water sand		60
Clay		70
Water sand		78
Gumbo		130
White shale		257
Brown sand	Set 6¾-inch pipe	259
Brown sand and lime		273
Brown and gray sand		297
Brown sand and shells		335
Shale		346
Brown sand and lime		356
Dark brown sand and shells		361
Dark brown sand		367
Brown and gray sand		378
Brown sand and lime		386
Dark brown sand		388
Gray sand and gravel		393
Brown and gray sand		400
Broken sand		403
Shale		406

The Wyche No. 40 was drilled with a spudder, and samples saved every 5 feet show the change in the Nacatoch sedimentation.

The log of the Premier Investment Company's McDade No. 1, Sec. 28, T. 19 N., R. 11 W., was also drilled with a spudder and continuous samples were saved from the top of the Nacatoch to the bottom of the well at a depth of 2,303 feet. A partial log extending from the surface through the Nacatoch is given in Table III, showing an increased thickening of 102 feet of the Nacatoch sand over that found in the Wyche log (Table II).

TABLE III

LOG OF PREMIER INVESTMENT COMPANY'S MCDADE NO. 1, SW. ¼ of NE. ¼, SEC. 28, T. 19 N., R. 11 W.

Formation	*Feet*
Surface	20
Red water sand	54
Red clay	60
Water sand	82
Dark gumbo	250
Gray gumbo and shale	275
Gumbo	363
White shale	413
White sandy shale	423
Gray shale	450
Lime rock—top of Nacatoch	452
Gray lime and sand, oil showing and salt water	492
Light gray sand	526
Fine gray sand (dark)	545
Hard fine sand	555
Brown sand and lime	565
Brown sand	595
Shale	602
Broken sand	615
Fine sand and shale	625
Sandy shale, light gray to white	662
Broken sand	700
Blue to white shale—top of Saratoga	760

ARKADELPHIA

The marine, chalky shale of Arkadelphia age marks the close of the Cretaceous sedimentation. In many places the change from Arkadelphia to Midway appears to be differentiated chiefly on paleontological data with no evidence of a true erosional hiatus between the two formations. In the Bellevue field the thickness of the Arkadelphia on the crest of the structure is about 40 feet. It is a white shale or limestone, lighter in color and more fossiliferous than the overlying black Midway shale and overlies the sand and limestone of Nacatoch age.

MIDWAY

The uniform thickness of 400–600 feet of black Midway shale in large areas of northern Louisiana and southern Arkansas is attrib-

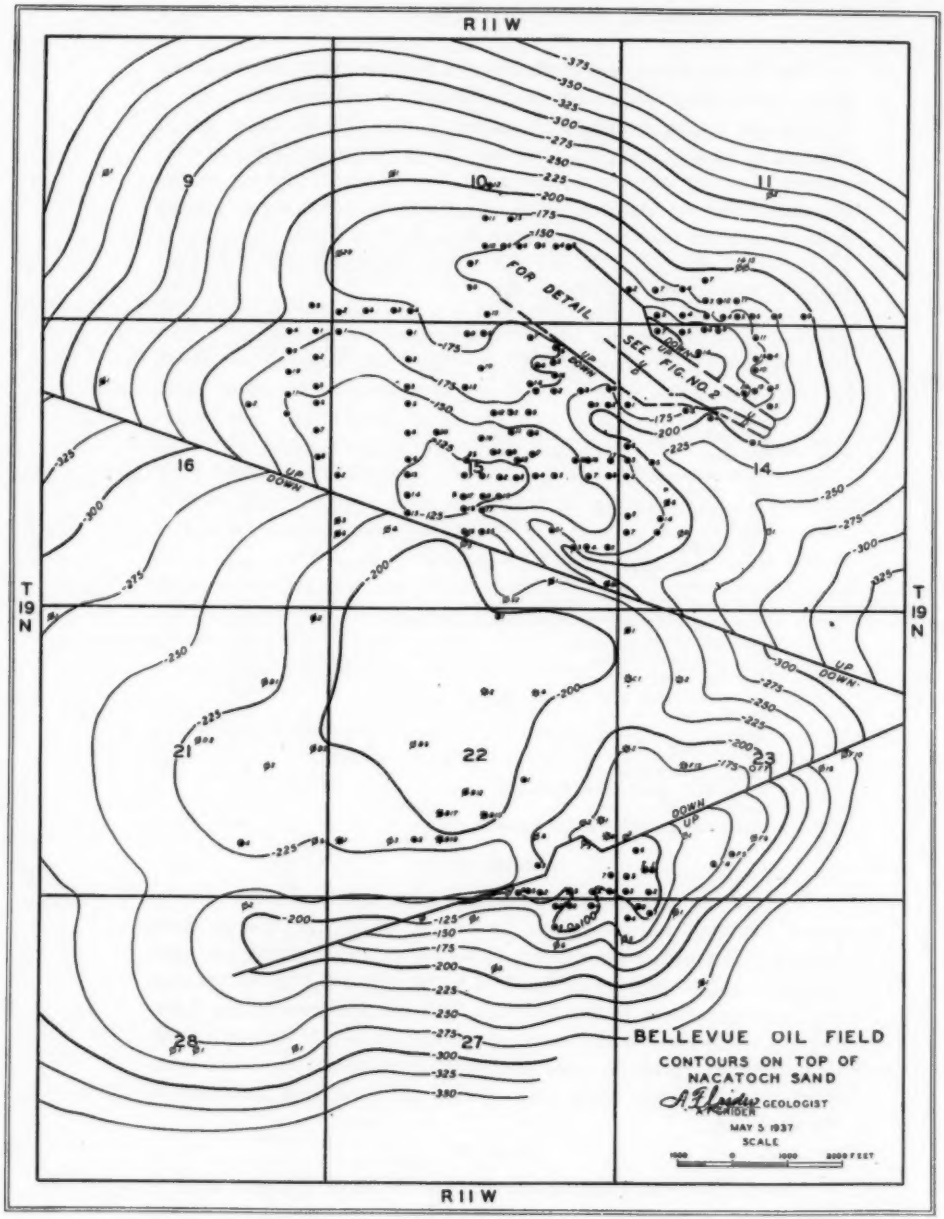

R 11 W
T 19 N
9
10
11
14
15
16
21
22
23
27
28
FOR DETAIL SEE FIG. NO. 2
UP
DOWN
BELLEVUE OIL FIELD
CONTOURS ON TOP OF
NACATOCH SAND
GEOLOGIST
MAY 5 1937
SCALE
1000 0 1000 2000 FEET

FIG. 1

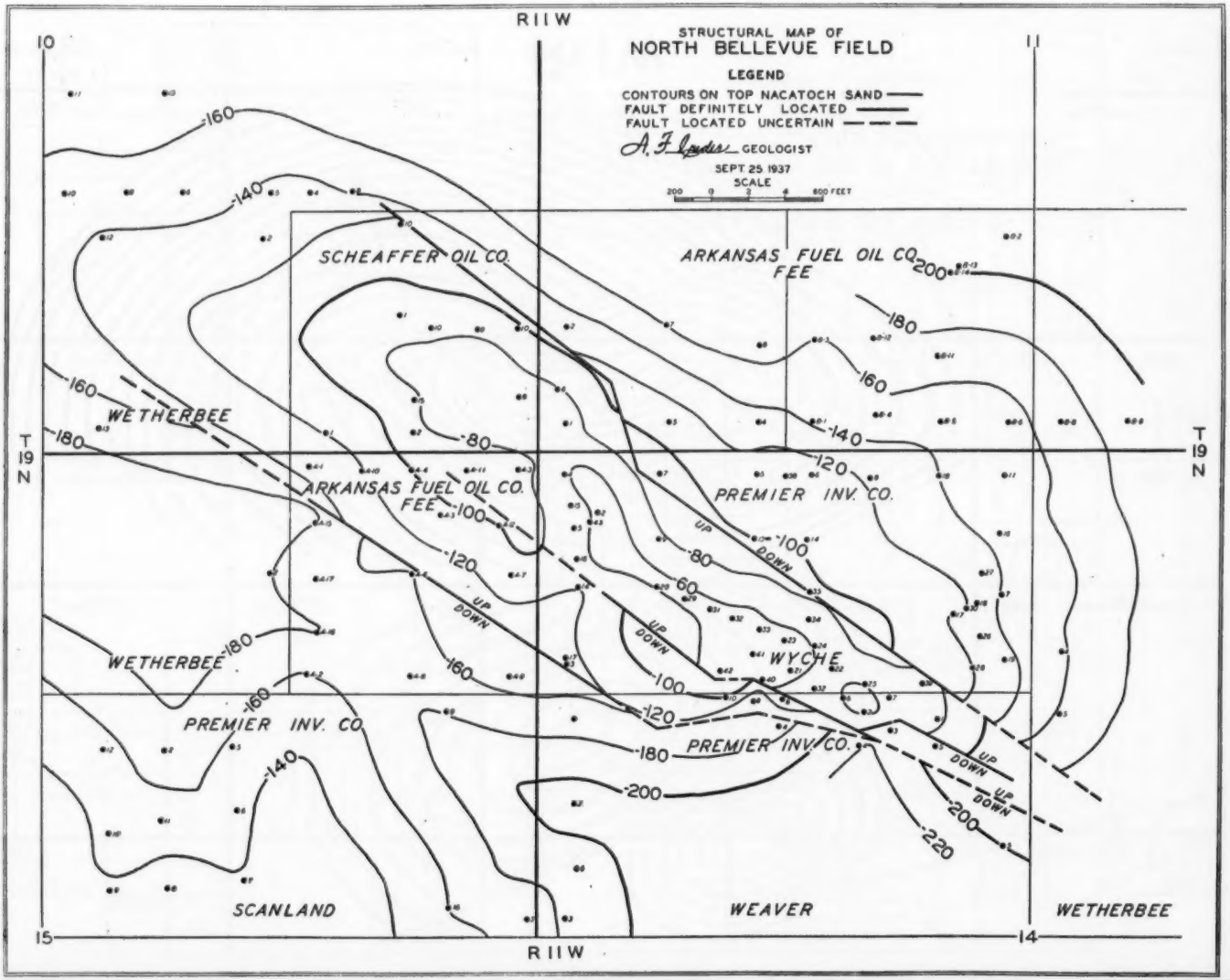

R11W
STRUCTURAL MAP OF
NORTH BELLEVUE FIELD
LEGEND
CONTOURS ON TOP NACATOCH SAND
FAULT DEFINITELY LOCATED
FAULT LOCATED UNCERTAIN
A. F. Lauder GEOLOGIST
SEPT. 25 1937
SCALE
200 0 2 4 600 FEET
10
11
15
14
T 19 N
R11W
SCHEAFFER OIL CO.
ARKANSAS FUEL OIL CO. FEE
WETHERBEE
ARKANSAS FUEL OIL CO. FEE
PREMIER INV. CO.
WETHERBEE
WYCHE
PREMIER INV. CO.
PREMIER INV. CO.
SCANLAND
WEAVER
WETHERBEE
UP
DOWN
160
140
180
200
220
120
100
80
60

FIG. 2

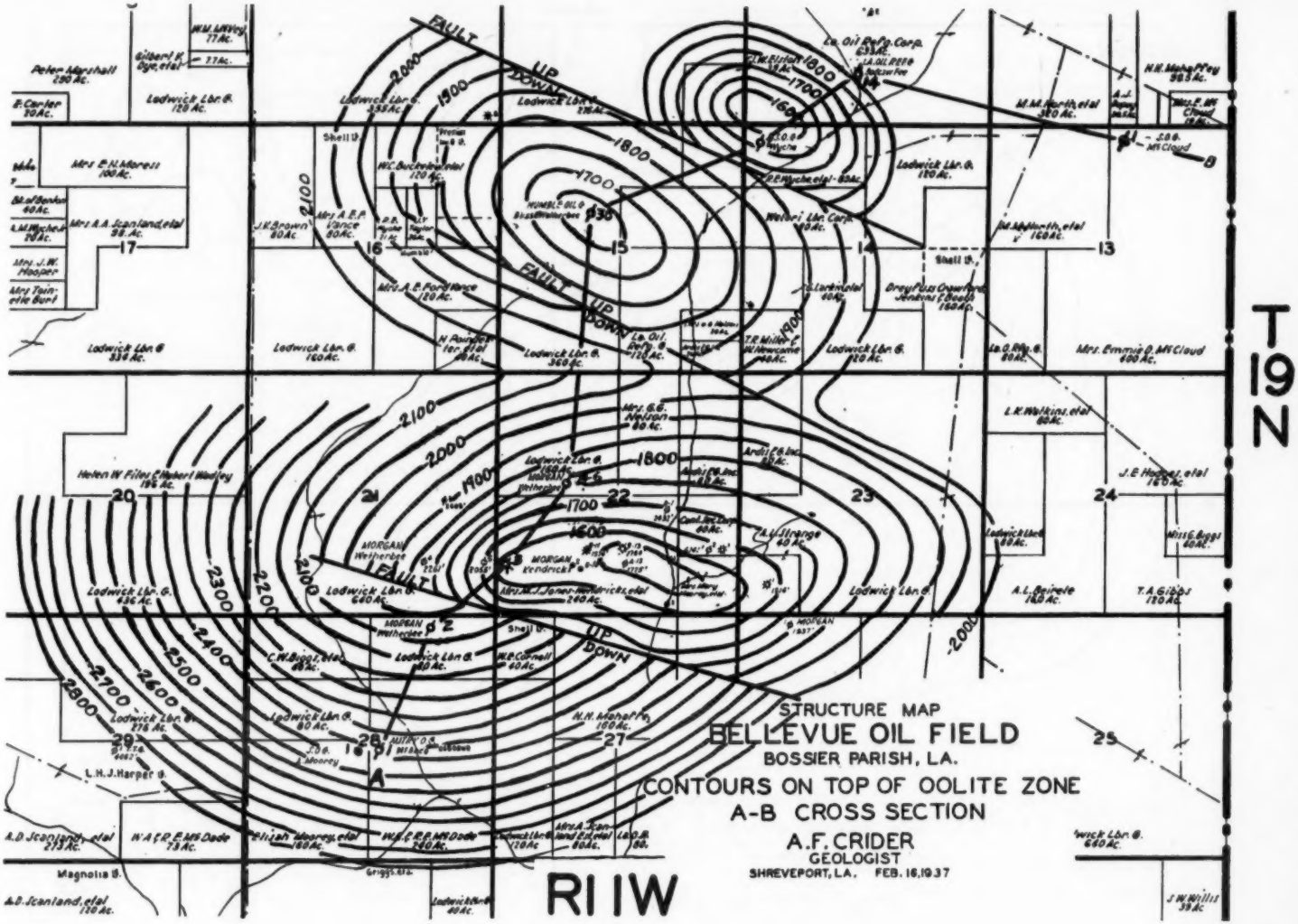

STRUCTURE MAP
BELLEVUE OIL FIELD
BOSSIER PARISH, LA.
CONTOURS ON TOP OF OOLITE ZONE
A-B CROSS SECTION
A.F. CRIDER
GEOLOGIST
SHREVEPORT, LA. FEB. 16, 1937
T 19 N
R 11 W
FAULT
UP
DOWN

FIG. 3

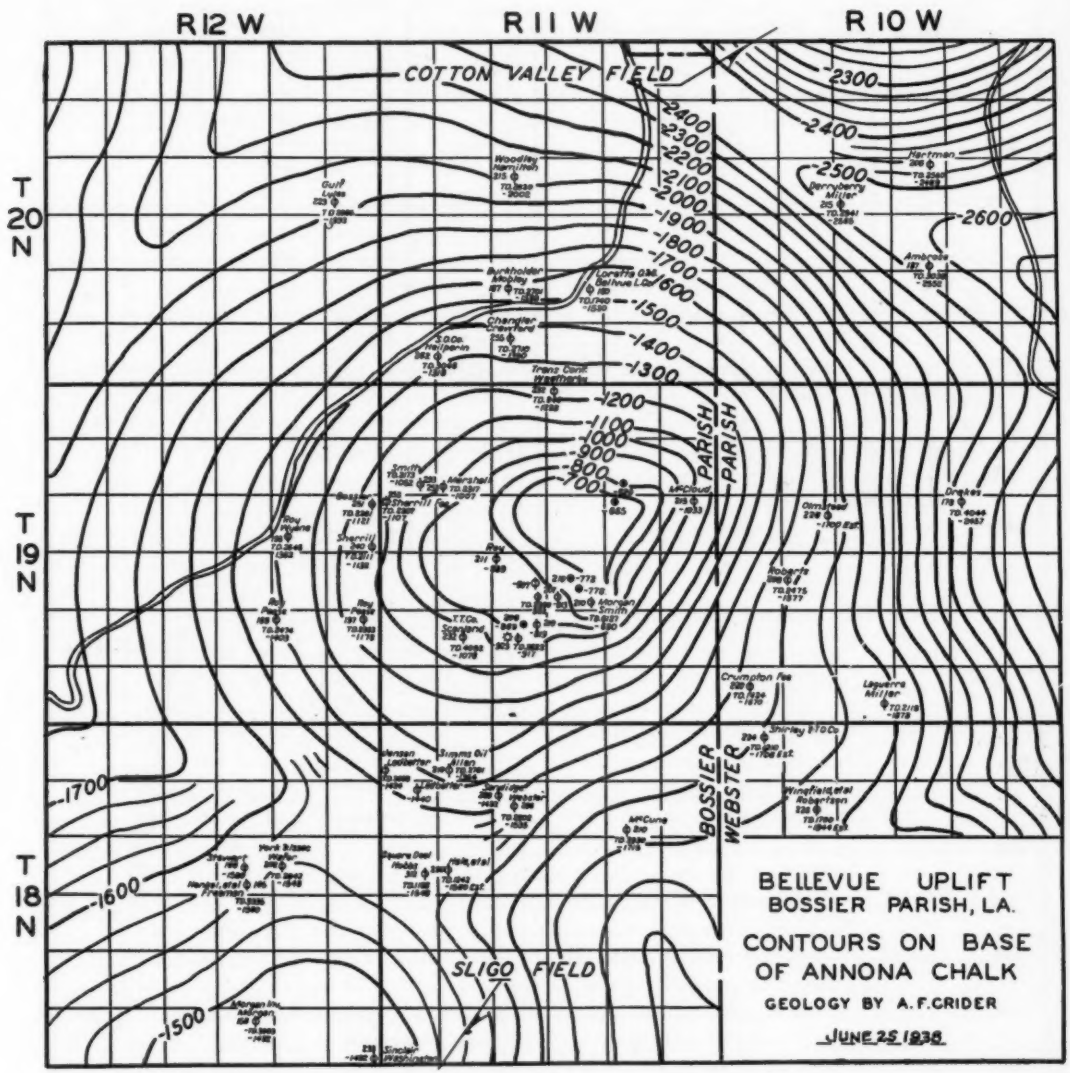

R12 W
R11 W
R10 W
T 20 N
T 19 N
T 18 N
COTTON VALLEY FIELD
SLIGO FIELD
BOSSIER PARISH
WEBSTER PARISH
-2300
-2400
-2500
-2600
-2400
-2300
-2200
-2100
-2000
-1900
-1800
-1700
-1600
-1500
-1400
-1300
-1200
-1100
-1000
-900
-800
-700
-1700
-1600
-1500
BELLEVUE UPLIFT
BOSSIER PARISH, LA.
CONTOURS ON BASE
OF ANNONA CHALK
GEOLOGY BY A. F. CRIDER
JUNE 25 1938

FIG. 4

FIG. 3

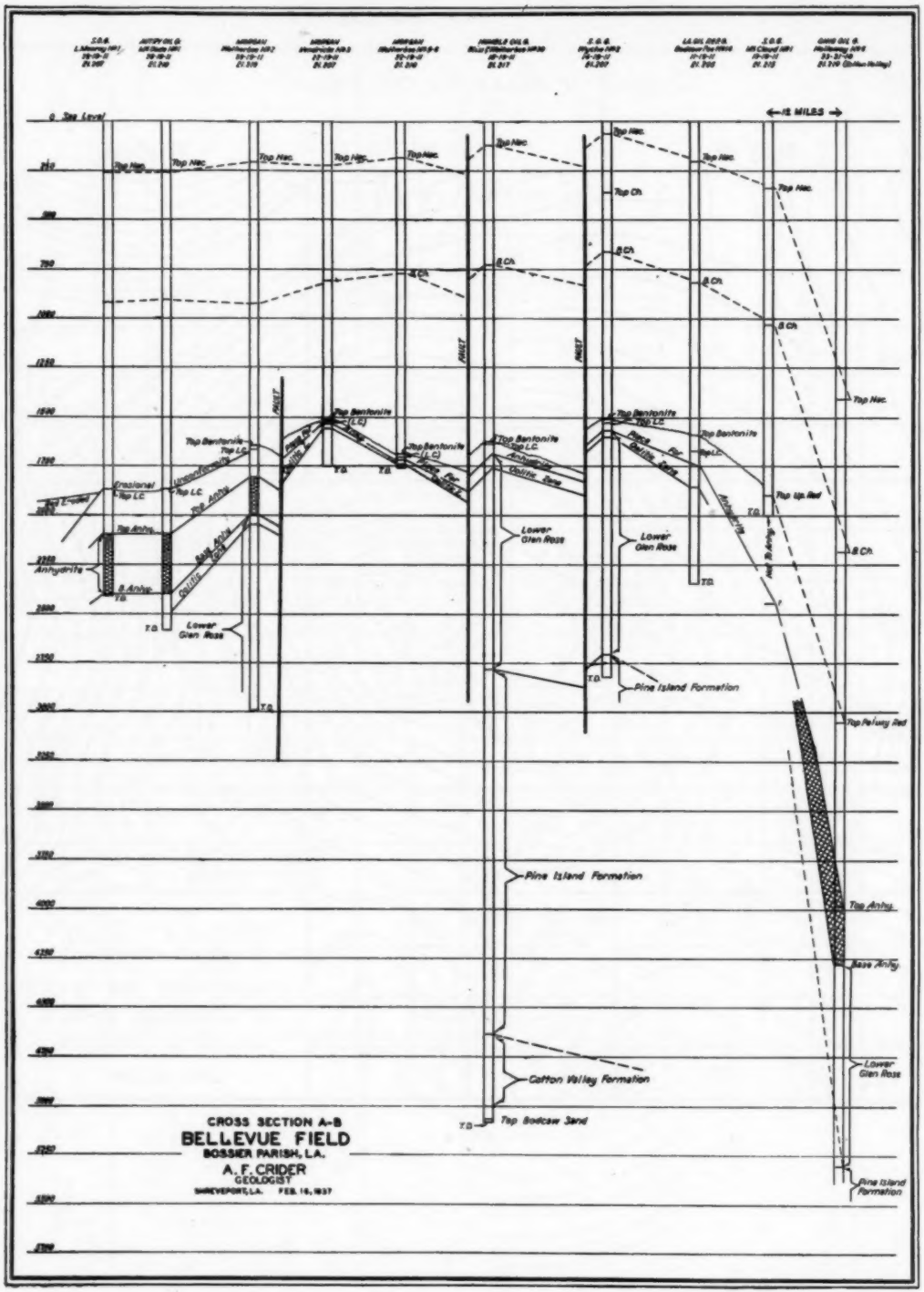

← 12 MILES →
Top Nac.
Top Ch.
B Ch.
Top Bentonite
Top L.C.
Top Anhy.
B Anhy.
Anhydrite
Lower Glen Rose
Pine Island Formation
Cotton Valley Formation
Top Bodcaw Sand
Top Paluxy Sd
Base Anhy.
T.D.
CROSS SECTION A-B
BELLEVUE FIELD
BOSSIER PARISH, LA.
A. F. CRIDER
GEOLOGIST
SHREVEPORT, LA. FEB. 16, 1937

FIG. 5

utable to the crustal stability of the region at the time of its deposition. The thickness of the Midway on the crest of the Bellevue dome has been partly reduced by truncation, leaving only 100 feet. The constant growth of the dome during deposition accounts in part for its extreme thinness. Here, as well as where it attains a greater thickness, it is a black, non-calcareous shale.

STRUCTURE

Bellevue is a buried dome, probably of rock-salt origin, with sands deposited across the top in which oil has accumulated. The structure has been produced by vertical forces which have arched the formations overlying the salt plug into a sharply folded dome, slightly quaquaversal in outline.

The effect and influence of the uplift can be seen in logs of wells 10–15 miles from the center of the field. Accumulation of oil, however, was confined to about 900 acres.

From the crest of the dome to the base of the syncline separating Bellevue and Cotton Valley the amount of structural uplift, as shown on Upper Cretaceous data, is approximately 1,800 feet and is as much as 2,500 feet on Lower Cretaceous data. The amount of uplift between Bellevue and Sligo on the southwest is about 1,300 feet on Upper Cretaceous data.

Four contour maps accompany this article. Figure 1 is contoured on top of the Nacatoch sand and is the result of data from practically all of the wells drilled in the field. It outlines the present subsurface conditions on top of the Nacatoch sand.

Figure 2 is a more detailed map of the northern part of the field and the faulted horst which caused the oil accumulation through the entire thickness of the Nacatoch sand, though in other parts of the structure production is confined to only a few feet of the uppermost Nacatoch sand.

Figure 3 is based on the fragmental evidence of the few wells which have been drilled to the top of the lower Glen Rose and deeper. The contours are drawn on top of the oölitic zone of lower Glen Rose age. In the time that elapsed between the deposition of the oölitic limestone and that of the uppermost beds of the Nacatoch sand, perhaps 1,000 feet or more of Comanche sediments were deposited above the oölitic limestone, after which the area was uplifted and subjected to a long period of erosion and again submerged below sea-level, and the Upper Cretaceous sedimentation followed.

Figure 4 is a subsurface map contoured on the base of the Annona chalk, showing the relation of the Bellevue structure to the surrounding territory.

Figure 5 is a southwest-northeast section across the Bellevue dome and includes one well in the Cotton Valley field.

FAULTS

Faulting is a factor to be considered in the interpretation of the structural problems of Bellevue.

The surface structure is easily recognized as an inlier of Midway shale with younger beds surrounding the shale. Due to the Pleistocene cover, all traces of surface faulting are hidden and evidence based on well-log data shows a series of normal, northwest-southeast faults, in the north part of the field, approximately paralleling each other, with the upthrow of each fault on the north. In the south part of the uplift there are additional northeast-southwest faults with the upthrow on the south. Between the two types of faulting is a graben which widens toward the west and wedges out completely between the faults toward the east. Production is largely confined to the two uplifted blocks which are separated by the central graben. In the lower zones, it is possible that producing sands will be found in the graben. In the map contoured on the oölitic zone, due to a lack of well-log data, not all faults are shown.

The amount of displacement of the various faults is shown in Figure 3. It is greatest in the southernmost, northwest-southeast fault in the northeast quarter of Section 27, where the throw, on the lower Glen Rose, is approximately 400 feet. In the center fault, in the south part of Section 15, the displacement on the lower Glen Rose oölite zone is about 250 feet. In the northernmost fault, in the northwest quarter of Section 14, the amount of displacement on the same zone is approximately 175 feet.

The greatest amount of displacement in the faults has apparently occurred at the apex of the dome and has gradually lessened toward the outer edges of the uplift.

What influence the faulting in Bellevue has had on the possible accumulation of oil in Comanche or older sediments is controversial. The claim may be made that the formations are so shattered by faulting that any oil that may be indigenous to the lower sands has leaked out through the faults.

The logical answer to such a question is that the same faults which would be expected to dissipate the oil in the lower sands have served as a trap for its accumulation in the Nacatoch sand. If the faults trap the oil in the upper sands they should trap it in the lower zones.

The detailed subsurface map (Fig. 2) of part of Sections 10, 11, 14, and 15 shows the complicated nature of the faulting and its rela-

tion to oil production. The highlights of this map are a northwest-southeast horst with two main attendant faults, which are about 600 feet apart in the northwest corner of Section 14, and a convergence in a southeasterly direction.

The amount of the uplift of the horst, in the center of the northwest quarter of Section 14, is approximately 50 feet and decreases toward the southeast and the northwest.

The full thickness of 146 feet and more of the Nacatoch sand within the uplifted block has been penetrated without finding water. Outside of this uplifted area water is found in the top of the Nacatoch formation where the oil is produced with the water.

CHARACTER OF CRUDE OIL

The Nacatoch oil from the Bellevue field is black, heavy, asphaltic base crude with a low cold test. The gravity ranges from 18° to 21° Bé. It is low in gasoline content and high in lube quantities. The price is 98 cents gross with 4 cents State severance tax. During the peak of production one or more of the buyers paid a premium for the oil for its high content of white mineral oils and other by-products. An analysis of the oil is given in Table IV.

TABLE IV

ANALYSIS OF BELLEVUE CRUDE OIL FROM NACATOCH SAND FROM DISCOVERY WELL, R. O. ROY'S RAILROAD LANDS NO. 7, MADE BY HUMBLE OIL AND REFINING COMPANY

Constituent	*Percentage*	*Degrees Bé. Gravity*
Gasoline	2.5	63.6
Naphtha	2.5	54.2
Kerosene	7.5	43.3
Gas oil	12.5	33.5
Spindle oil	30.0	27.2
Lubricating oil	38.0	21.3
Loss and coke	0.7	

Gravity of the sample analyzed, 19.3, Bé.

DEEPER POSSIBILITIES

Since the development of the Rodessa, Cotton Valley, Schuler, and Buckner fields with production from the Glen Rose, Bodcaw, and older formations, Bellevue stands out as one of the attractive prospects for testing these lower beds. Morgan's Smith No. 2, in the southern part of the field, drilled through the Bodcaw sand with only a showing of oil and gas reported from that zone. The "Jones sand," and the "Smackover lime" of Schuler and Buckner have not been reached in Bellevue and offer possibilities for production. Allowing 1,500 feet for regional thickening of the Pine Island and Cotton Valley

formations, between Schuler and Bellevue, the top of the Smackover limestone should be found in Bellevue, if present, at a depth of 7,360 feet. The Pine Island formation in the Schuler field comprises something less than half of the interval from the top of the Pine Island to the Smackover limestone. The Pine Island formation has increased 687 feet in thickness between Schuler and Cotton Valley. An estimate, therefore, of 1,500 feet for the total thickening of the Pine Island and Cotton Valley formations between Schuler and Bellevue gives the estimated depth of 7,360 feet for the top of the Smackover limestone in the Bellevue field.

PRODUCTION

Since its discovery in 1921 to January 1, 1938, the Bellevue field has yielded a total production of 9,860,430 barrels. Its peak production was reached in 1923. From the close of 1931 to the close of 1933 the field was closed and all the wells abandoned on account of low prices. A new drilling campaign was inaugurated by the Premier Investment Company, who, in 1934, took over some abandoned leases, redrilled and reworked its properties, and since 1933, production for the field has increased, as shown in Table V. These production figures compiled by the Standard Oil Company of Louisiana show that the shallow Bellevue field has produced more oil per acre than any other field in northern Louisiana except Homer and Rodessa.

The area of the field from which production has come is 900 acres and the yield per acre to January 1, 1938, is 10,996 barrels.

TABLE V

PRODUCTION

Year	*Barrels*
1922	1,479,985
1923	2,250,057
1924	1,912,787
1925	1,212,724
1926	807,689
1927	495,265
1928	343,355
1929	235,490
1930	234,785
1931	103,930
1932	None
1933	None
1934	63,825
1935	None
1936	228,575
1937	280,130

A redrilling of one 80-acre tract, which was abandoned, with casing pulled, in 1932, has resulted in a total new production to December 31, 1937, of 3,139 barrels per acre.

ACKNOWLEDGMENTS

The writer wishes to express his sincere appreciation for helpful criticism and advice to Roy Hazzard of the Gulf Refining Company; to C. L. Moody of the Ohio Oil Company for reading and criticizing the manuscript; to G. D. Thomas of the Shell Petroleum Company for microscopic descriptions of samples from one of the wells recently drilled in the field; to the geological staff of the Standard Oil Company of Louisiana for cordial coöperation in supplying paleontological data on formational contacts in different wells; and to Kenneth L. Wickett, president of the Premier Investment Company, for detailed information of wells drilled in the complicated faulted district in the northern part of the field and for a complete set of drilling samples from a well on the south flank of the uplift.

BULLETIN OF THE AMERICAN ASSOCIATION OF PETROLEUM GEOLOGISTS
VOL. 22, NO. 12 (DECEMBER, 1938), PP. 1682-1686, 1 FIG.

RELATION OF ROUGH CREEK FAULT OF KENTUCKY TO OUACHITA DEFORMATION[1]

WILLIAM L. RUSSELL[2]
Owensboro, Kentucky

ABSTRACT

The Ouachita structures west of the Mississippi Embayment form a belt extending from the Mexican border to Arkansas. The Rough Creek fault of Kentucky and Illinois is part of a system of faults and steep folds which is similar to the Ouachita structures in its general trend and in the occurrence of thrusting from the south. The Ouachita structures show no sign of diminishing where they pass beneath the Mississippi Embayment on its west side, although the structures of the Rough Creek fault system increase toward the west in the amount of thrusting and in the intensity of deformation. The Rough Creek fault system is considerably north of a projection of the Ouachita deformation across the Mississippi Embayment, but this may be explained by assuming that the belt of deformation bends around the Ozark uplift as it bends around the Llano uplift of Texas. Additional evidence is obtained from northwestern Tennessee, where wells in the Mississippi Embayment between the Ouachita and Rough Creek structures have found deformed and altered Paleozoic rocks.

INTRODUCTION

It is known that there is a belt of thrust faults and sharp folds which extends from the Mexican border to Arkansas, and forms one of the major structural features of the continent. As these Ouachita structures show no sign of diminishing where they disappear beneath the Cretaceous and Tertiary deposits of the Mississippi Embayment, it seems reasonable to expect that structures of the same system would be exposed on the eastern side of the embayment. The Rough Creek fault system of Kentucky and the various folds associated with it show some similarities to the Ouachita structures on the west, and it may therefore be of interest to discuss the evidence as to whether the Rough Creek fault is an eastern extension of the Ouachita deformation.

The belt of folded and faulted strata is thought to extend northeastward from Mexico to the Solitario uplift of Brewster and Presidio counties, Texas, where it is exposed in a pronounced dome. Toward the east it passes under the Cretaceous again, but is brought to the surface in the Marathon uplift of Brewster County. From there to the Ouachita Mountains of Oklahoma and Arkansas it is concealed by Cretaceous deposits, but it is known from well logs to extend around the Llano uplift to the Ouachita region. Throughout this belt there is evidence of overthrusting from the south and southeast.

[1] Read before the Kentucky Academy of Science, May, 1938. Manuscript received, July 16, 1938.

[2] Geologist, Michigan Devonian Petroleum Company.

CHARACTERISTICS OF ROUGH CREEK FAULT SYSTEM

The Rough Creek fault, the largest structural feature of the western Kentucky geosyncline, may be traced almost continuously from eastern Grayson County to the Ohio River. Near Shawneetown it crosses the Ohio River into Illinois, where it is known as the Gold Hill fault. West of where this fault dies out, the system is continued by the McCormick and New Burnside anticlines. The McCormick anticline turns southwest in its western part, near where it approaches the Mississippi Embayment.

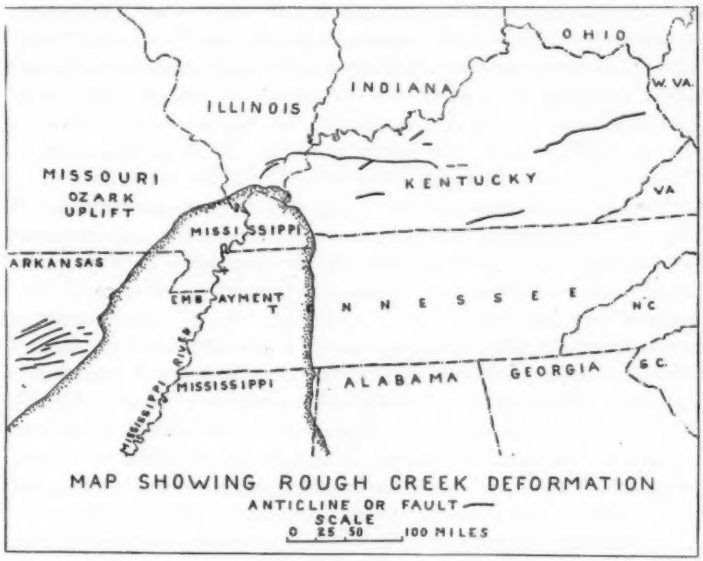


FIG. 1

In addition to the Rough Creek fault itself, there is a system of similar faults or anticlinal folds, which may be recognized by its trend and general characteristics. As stated by the writer[3] in an earlier paper, more or less isolated structures belonging to this system may be found scattered from eastern Kentucky to southern Illinois, although no single structure extends over this distance. The known structures of this system are shown in Figure 1, which includes those shown on maps of the Kentucky and Illinois geological surveys, as

[3] William L. Russell, "Geology of Oil and Gas Fields of Western Kentucky," *Bull. Amer. Assoc. Petrol. Geol.*, Vol. 16, No. 3 (March, 1932), pp. 232–33.

well as those mapped by the writer. Many more structures of this type may be found by further work in Kentucky and Tennessee. The largest and most pronounced structure of this system is the Rough Creek fault. The strata just south of this fault are uplifted relative to those on the north, and on the north edge of the uplift there is a fault or steep dip. In places there is a graben or syncline just north of the uplift, but elsewhere there may be merely regional dip, with little structural disturbance. In some places the strata just south of the fault plane simply dip southward at somewhat high angles, gradually flattening away from it, and in other areas there is a long, narrow anticline, extending parallel with the fault just south of it, and showing steep north dips close to the fault, and gentler dips on its south flank. In some localities the strata just south of the fault plane are deformed into very small, steep folds. Some wells on the Rough Creek uplift have apparently found thin sections of the Mississippian, suggesting that this structural feature began to develop in Mississippian time. The sandstones in the highly deformed strata close to the fault plane are commonly indurated or less porous than ordinary sandstones, and some of them are practically quartzites. Where the surface strata show dips of 4°–5° or more, the Chester sandstones have generally been found, by drilling, to be too low in porosity to produce oil. The Rough Creek fault itself may be a single break, or it may consist of two or more faults separated by narrow blocks or slices composed of more or less shattered and tilted rocks. One of the most remarkable features of the Rough Creek fault is the occurrence along it of small, more or less isolated masses of older rocks which have been elevated far above their normal position. In places these blocks have been thrust up so that the strata composing them are nearly 1,000 feet above their normal structural levels north and south of the fault.

It is scarcely possible to obtain direct evidence of the dip of the Rough Creek fault from exposures. However, the nature of the structures south of the fault strongly suggests thrusting from that direction. Furthermore, in western Kentucky the strata just north of the fault plane dip steeply southward in a few places, suggesting that they have been overturned by the thrusting, and in southern Illinois shear planes along the fault, which may be more or less parallel with the fault plane, dip south at angles of 45°–70°. More definite evidence is available from the logs of drilled wells. Some of the wells begun just north of the fault apparently did not go through it, and the well drilled by M. M. Hobson and T. M. Bane on the Bamberry Hidgon farm, about 2 miles east of Grayson Springs, Grayson County, Kentucky, seems to have begun just south of the fault, and to have pene-

trated it, finding an abnormally large interval between the Cypress sandstone and the Chattanooga shale.

Aside from the Rough Creek fault itself, the other structures belonging to the same system exhibit the same characteristics less strongly developed. The Twin Tunnels fault of Muhlenburg County, Kentucky, shows in some places features that suggest compressive forces acting from the south. The thrusting along the various structures of the Rough Creek fault system seems to decrease toward the east, and east of Grayson County no reverse faults are known. In this area on the east, structures belonging to this system are more difficult to recognize, but they still preserve their east-west trend and consist of monoclinal uplifts bordered on the north by a fault with a downthrow on the north or by a graben, or are represented by anticlines which tend to have their steepest dips on their north flanks.

EVIDENCE CONNECTING ROUGH CREEK FAULT SYSTEM WITH OUACHITA DEFORMATION

The general nature of the Ouachita deformation suggests that it extends to the eastern side of the Mississippi Embayment. As previously stated, it seems unlikely that a belt of structures which extends from Mexico to the Mississippi Embayment, and which is strongly developed near the embayment, would disappear entirely beneath it. The structures of the Rough Creek fault system have the same trend as those of the Ouachita Mountains, and the thrusting also came from the south in both cases. The most easterly anticlinal axes of the Ouachita deformation shown by Croneis[4] on his map of the Ouachita area have been plotted in Figure 1. It is at once evident that if these axes were projected across the Mississippi Embayment they would emerge from it somewhere in central Tennessee about 100–125 miles south of the Rough Creek fault. At first sight this seems to constitute serious evidence against the idea that the two systems of structures are continuous. Nevertheless, there is some evidence suggesting that the Ouachita folding turns northeast under the Mississippi Embayment to connect with the Rough Creek structures. In its course from the Mexican border the belt of Ouachita deformation swings around the Llano uplift of central Texas, and if it swings around this uplift, it would also be expected to swing around the Ozark uplift, which would give it a northeast trend under the Mississippi Embayment. Furthermore, the Rough Creek structures at their extreme western end turn southwestward, although this may be

[4] Carey Croneis, "Geology of the Arkansas Paleozoic Area," *Arkansas Geol. Survey Bull.* 3 (1930), Pl. 1-A.

merely a local feature, and the Ouachita folds of Arkansas also show a slight tendency to turn northeastward near the embayment.

Subsurface information obtained from wells drilled in the Mississippi Embayment in northwestern Tennessee also supports the theory that the Ouachita structures turn northeastward under the embayment. Born[5] mentions a well in southwestern Obion County, Tennessee, which encountered deformed Paleozoic strata, some of which showed slaty cleavage, and in a recent personal communication Born[6] writes that three other wells in the same vicinity have penetrated Paleozoic rocks which are definitely disturbed, local beds having been metamorphosed and some of the sandstones converted to quartzites. The general location of these wells is shown by the cross in Figure 1. As the most northerly fault or steep fold in the Ouachita area is ordinarily north of the area in which slaty cleavage or metamorphic rocks are found, it would be expected that the outermost fold or fault in the vicinity of these wells would be some distance northwest, which would place it nearly in a direct line between the area where the Ouachita folds enter the Mississippi Embayment, and the most western exposed structures of the Rough Creek fault system.

Although the evidence at present available supports the theory that the Rough Creek fault system of Kentucky and Illinois is the diminishing eastern extension of the Ouachita belt of deformation, the final answer to this problem must be sought in further subsurface or geophysical information about the Paleozoic rocks beneath the Mississippi Embayment. If the structures of the Rough Creek fault system as shown in Figure 1 were added to the Ouachita belt of deformation, the known length of the belt would be increased by 50 per cent, and it would extend across half the continent.

[5] K. E. Born, *Trans. Amer. Inst. Min. Met. Eng.*, Vol. 123 (1937), pp. 453–54.

[6] K. E. Born, personal communication, June 2, 1938.

BULLETIN OF THE AMERICAN ASSOCIATION OF PETROLEUM GEOLOGISTS
VOL. 22, NO. 12 (DECEMBER, 1938), PP. 1687-1691

GEOLOGICAL NOTES

AN HISTORICAL DOCUMENT OF INTEREST TO PETROLEUM GEOLOGISTS[1]

WILBER STOUT[2]
Columbus, Ohio

The production of petroleum on a commercial basis began in Ohio about one year after Drake had brought in his famous well in 1859 in Pennsylvania. Petroleum was drilled for and obtained in 1860 at Macksburg and on Cow Run in Washington County. These strikes caused great excitement and much activity in the formation of new companies and in the leasing of land. The prospectus of the Ohio Petroleum Company, presented in the following pages, is probably representative of those of that time. The consulting geologist, Professor E. B. Andrews, graduated from Marietta College in 1848 and taught there from 1851 to 1869, when be became a member of the staff of the Geological Survey of Ohio. He was thoroughly familiar with the geology of the region and was one of the leading authorities on petroleum and natural gas of that time.

PROSPECTUS

OF THE

OHIO PETROLEUM COMPANY

OFFICE:

NO. 4 BROAD STREET

(ROOMS 11 AND 12, SECOND FLOOR.)

NEW YORK.

E. S. DODGE & CO., PRINTERS AND STATIONERS, 84 JOHN STREET

1864.

President,
WILLIAM A. SHREVE.

Secretary,
ALLEN D. VORCE.

Treasurer,
JOHN R. PENN.

Superintendent,
WILLIAM BROUGH.

[1] Manuscript received, October 24, 1938.

[2] State geologist of Ohio.

DIRECTORS.

WM. A. SHREVE, Bordentown, N. J. — C. V. CULVER, New York
JOHN L. McKNIGHT, Bordentown, N. J. — WM. BROUGH, New York
BATEMAN GOE, Pittsburgh, Pa. — WM. C. TILLSON, Oil City
L. H. CULVER, New York.

THE OHIO PETROLEUM COMPANY

This Company has been organized under the Laws of the State of New York, and in conformity with the Laws of Ohio, and certificates of incorporation have been duly filed.

CAPITAL STOCK

$1,000,000 in 10,000 Shares of $100 each.

LOCATION OF PROPERTY

The property of the Company is situated on Federal Creek, Morgan County, Ohio, ten miles from Big Run Station, on the Cincinnati and Marietta Railroad, and fourteen miles from the town of McConnelsville, on the Muskingum river. It embraces 1,144 acres of land, 860 acres of which is held in fee, and the remainder by lease. It has two miles in extent of broad valley land, suitable for boring wells.

Indications, such as gas and oil springs, similar to those which led to the discovery of oil in Pennsylvania, have been known here to the earliest inhabitants.

After the first wells were bored on Oil Creek, the land in the neighborhood of these oil springs was parceled off into small lots, and numerous holes were drilled to a shallow depth by hand power. The operatives were mainly men of limited means, and no experience whatever in the business. In this way, about 20,000 barrels of oil were taken out in 1861, but the working soon after ceased, owing to the limited market at that period.

The division of oil lands into small ownerships is detrimental to the general interest, as the numerous holes furnish an outlet for the escape of gas, and introduce water into the oil veins. Beside this, small contiguous ownerships of well interests so common in the oil regions of Pennsylvania constantly create clashing interests and consequent litigation. The large area of territory under the ownership and control of this Company will enable them to protect themselves against these difficulties, and work the oil veins in the most judicious manner. With this knowledge, acquired after a long experience, a party of gentlemen from Oil Creek, in the Spring of 1863, purchased the separate land interests on Federal Creek, so as to embrace all the valuable oil lands of that region.

THE COST OF TRANSPORTATION

The whole Western market is open to the production of this territory without competition.

It is 14 miles from McConnelsville, on the Muskingum River, a tributary of the Ohio. To this point oil is carted for $1 per barrel. At McConnelsville, ample steamboat transportation is afforded to all points that may be reached by the Great Western rivers.

The interior of the country by railroad is reached by a cartage of ten miles, at 75 cents per barrel, to Big Run Station, on the Marietta and Cincin-

nati Railroad. From this point it is only 171 miles from Cincinnati, and of quick transit to Chicago or other points in the North West, at a cost of $1 to $2 per barrel less in transportation to all Western markets, than from the oil lands of Pennsylvania. The Eastern markets can be reached at tide water at Baltimore, a distance of 401 miles from this property by the Baltimore and Ohio Railroad.

The distance of the oil lands of Pennsylvania from Oil City to tide water at New York is 552 miles. The difference in transportation to tide water being 151 miles in favor of this property. A liberal profit is thereby insured by this difference of transportation under any future competition from the Pennsylvania Oil Regions.

GEOLOGICAL REPORT

Professor Andrews, of Marietta College, who made a geological examination of these lands in June of this year, makes use of the following language respecting them.

"The wells hitherto bored are all shallow wells, and all, or nearly all the oil has been obtained at a less depth than a hundred feet from the surface. No deep wells have been bored. Gas is abundant, and in one or two cases has caused flowing wells. The success of these shallow wells proves two most important points, viz: First, that there are many fissures in the underlying rocks, and second, that these fissures contain oil. To my mind these facts strongly warrant the conclusion that deeper wells would strike other and probably larger fissures, and yield very remunerative quantities of oil."

QUALITY OF OIL

It is of the finest quality, being forty-two gravity, and will always command the highest price in the market for refining purposes. The local demand will take three hundred barrels per day from this region.

COAL FOR ENGINES, REFINING, AND GENERAL MARKET

There are two veins of bituminous coal on these lands, one of three and one-half feet thick, the other has not been tested. This coal is known to be of the most superior quality, and underlies a considerable portion of this Company's lands. To mine and cart it a few rods to our pumping engines, only involves a cost of some five cents per bushel, while fifty cents per bushel is the ordinary price at the Pennsylvania Oil Wells. Nowhere in the world can refining be conducted at a less cost than on this property, owing to the close proximity of Petroleum to the fuel.

This coal alone would justify the construction of a railroad outlet over an easy grade of ten miles, down Federal Creek valley to Big Run station on the Marietta and Cincinnati Railroad. The rapid development of the Petroleum will soon make this railroad an imperative necessity.

PROGRESS OF THE WORK

The work is under the local management of Mr. H. H. Todd, assisted by Mr. Phillips, whose experience in the oil regions of Pennsylvania qualifies him for this position.

The development has progressed in every respect as favorably as did that of Oil Creek, Pennsylvania, furnishing shallow wells in places, only, as did, for

example, the Buchanan farm at the lower end of Oil Creek, and the Watson flats at the upper end.

The Company now have thirteen wells bored and three more in progress, and have ample capital in their working fund to place these sixteen wells in successful working order, and also to pay all expenses for some time to come, leaving the proceeds of oil to be applied to the payment of dividends exclusively.

Three engines are now placed and at work, yielding in the aggregate something over one hundred barrels per day from three wells.

Four more engines are on the ground and now being placed at the wells, and will be at work, pumping in a few days.

Four additional engines are on the way to the Company's property, and will be put in full operation within the month of October.

Five more engines besides these above named are purchased, which will be placed and at work by the first of December next; making sixteen engines in all.

PRESENT AND ESTIMATED PROFITS AFTER FIRST OF DECEMBER

Three wells now producing one hundred barrels per day, which is selling at $8 per barrel,	$ 800
Thirteen wells now in progress, may safely be estimated at only an average of fifteen barrels per day each, or one hundred and ninety-five barrels, at eight dollars per barrel,	1,560
	$2,360
Cost of working sixteen wells at eight dollars per day each	128
Leaving a net daily profit of	$2,232

Or $669,600 on a year of three hundred days on a capital of $1,000,000.

With a boring surface only limited by the demands of the market and the further development of the property by the stockholders, the Company may extend their operations indefinitely.

COMPARISON WITH OTHER COMPANIES

This Company will compare favorably with the best Oil Companies on Oil Creek.

Several of the earliest and present stockholders in the Columbian Oil Company are also large stockholders in this. One of these gentlemen, personally familiar with the property of both Companies, has stated the following facts, which may be relied upon.

"The Ohio Petroleum Company has twice the number of acres of the Columbian Oil Company, and nearly four times the amount of drilling ground. It will pay as large a dividend on its capital of $1,000,000 as the Columbian Oil Company does on its present selling price of $5,000,000. There is this advantage in favor of the Ohio Petroleum Company, it has only been half a year under systematic development, producing its oil from wells no deeper than one hundred and twenty feet, while the Columbian Oil Company is now drawing from its deep veins."

DIVIDENDS

From the sales of oil, and the oil on hand, there is now $21,000 applicable to dividends, being over two per cent, on the whole capital stock. The three wells now in operation are producing at the rate of nearly two per cent per month. With the 16 wells under way, it is not unreasonable to expect dividends of four or five per cent per month, unless the price of oil should be greatly reduced.

The board of directors propose to make their first monthly dividend on the first day of December next. By judicious and economical efforts, and a vigorous prosecution of the work, the management will aim to make the dividends uniform and regular.

SUBSCRIPTIONS

For the balance of the stock are invited at par.

For further information, application may be made to Allen D. Vorce, Esq., Secretary, at the Office of the Company, No. 4 Broad Street, New York.

BULLETIN OF THE AMERICAN ASSOCIATION OF PETROLEUM GEOLOGISTS
VOL. 22, NO. 12 (DECEMBER, 1938), PP. 1692-1697

REVIEWS AND NEW PUBLICATIONS

* Subjects indicated by asterisk are in the Association library and available to members and associates.

SYMPOSIUM ON SEDIMENTS

REVIEW BY PARKER D. TRASK[1]
Washington, D. C.

"Sediment-Heft" (Symposium on Sediments). *Geol. Rundschau* (Stuttgart), Bd. 29, Heft 3–5 (July, 1938), pp. 147–461; 79 figs.

This paper-bound volume of more than 300 pages is a symposium on many phases of sedimentation. It contains 22 articles, all written in German. Some are summaries of the present state of knowledge; others present data for the first time. For the large part, the papers deal with the conditions of formation of sediments based on studies of recent deposits. Most of the papers contain extensive bibliographies. In all, approximately 550 citations to the literature are given. The scope of the symposium is so broad that it is impracticable in a short review to attempt to abstract and comment on each paper; suffice it to say, however, that it contains much interesting and useful information. The titles of the papers are as follows: (1) "Recent and Fossil Sediments—Earth History with or without the Study of Present-Day Sediments," by K. Andree; (2) "The Interpretation of Sediments," by Otto Pratje; (3) "A Method of Classifying the Size-Distribution of Clastic Sediments," by Helge Gry; (4) "Sedimentary Petrographic Methods of Studying Sandy Sediments," by Karl-Heinz Sindowski; (5) "Clays," by Carl W. Correns; (6) "The Question of Authigenic Formation of Mica in Young Sediments," by C. W. Correns; (7) "Results of the Sedimentary Petrologic Investigations in the Netherlands and Adjacent Territory," by C. H. Edelman; (8) "Investigations in the Straits of Dover with the Research Ship 'Oceaan'," by Joh. van Veen; (9) "The Heavy Mineral Deposits of the German Coast," by Erich Wasmund; (10) "Mineralogical and Chemical Investigations of Concentrates of Ore Minerals on the Coast of the North Sea and Baltic Sea in Germany," by Kurt Lamcke; (11) "Physical Chemical Observations on Sediment Diagenesis in Post-glacial Sediments in Eckernförder Bay on the Baltic Sea," by P. Groschof; (12) "Chemical Microbiological Observations on Sediment Diagenesis in Post-Glacial Sediments in Eckernförder Bay on the Baltic Sea," by C. R. Baier; (13) "On the Rate of Sedimentation in Recent Deep-Sea Sediments," by Wolfgang Schott; (14) "Stratigraphy of Recent Deep-Sea Sediments on the Basis of Their Foraminifera Content," by Wolfgang Schott; (15) "The Genealogical Tree of the Sediments in an Arid Region—Observations in Southern Namib in Southwest Africa," by G. Knetsch; (16) "Heavy Minerals and Paleogeography," by R. Brinkmann; (17) "Primary Directions in Sediments of the Rhine Geosyncline," by Hans Cloos; (18) "Unconsolidated Sediments and Structural Geology," by A. von Moos; (19) "Rock Weathering and Soil Formation by Sedimentary Rocks with Special Respect to Conditions in Switzerland," by M. Gschwind; (20) "Applied Geology and Structural Geology as Taught in the Technical Institutes," by H. Gallwitz;

[1] United States Geological Survey. Manuscript received, October 21, 1938.

(21) "On the Formation and Composition of Organic Sediments," by Karl Krejci-Graf; (22) "Transformations of Wood on Its Way to Coal," by Karl A. Jurasky.

ANNUAL REVIEWS OF PETROLEUM TECHNOLOGY, 1937

REVIEW BY EUGENE A. STEPHENSON[1]
Lawrence, Kansas

Annual Reviews of Petroleum Technology, 1937. Vol. 3 (August, 1938). 490 pp., 9 illus. Cloth. Price, 11 s, postpaid. The Institute of Petroleum, Aldine House, Bedford St., Strand, London, W. C. 2.

A compilation of excellent reviews, summarizing the progress of various phases of petroleum research and technology. Each of the twenty-seven chapters is the work of an outstanding individual in some special field, so that the authorships alone present an imposing group of names.

Chapters of special note are those dealing with petroleum geology, production engineering, production, transportation, many phases of refining, various types of internal combustion engines, an exhaustive discussion of cracking processes and of the chemistry and physics of the hydrocarbons, and the production of synthetic fuels.

A comprehensive bibliography follows each chapter so that the book becomes a valuable addition to every public library as well as to all who are interested in the petroleum industry, and is entitled to rank as an essential addition to petroleum literature.

RECENT PUBLICATIONS

AFRICA

Geologie Afrikas (Geology of Africa), Pt. 3, 2d half, by Erich Krenkel. Part of the series *Geologie der Erde*, pp. 1305–1918; 10 pls., 3 tables, 181 figs. Gebrüder Borntraeger, Berlin (August, 1938). Price, paper, RM 54. Both halves of Part 3, the first of which was published in 1934, may be obtained bound together. Price, RM 85.

ARIZONA

*"An Analysis of Cross-Lamination: the Coconino Sandstone," by Parry Reiche. *Jour. Geol.* (Chicago), Vol. 46, No. 7 (October–November, 1938), pp. 905–32; 6 figs.

ARKANSAS

"Magnetic Declination in Arkansas, 1935," by P. H. Williamson and Evald Hermansen. *U. S. Coast and Geodetic Survey Serial 601* (April, 1938). 41 pp., 3 figs. 6×9¼ inches. Paper. Price, $0.15. Order from Supt. Documents, Govt. Printing Office, Washington, D. C.

AUSTRALIA

Die alten Kerne (The Ancient Coigns), Abschnitt VII (1938), *Middle and West Australia*, by E. de C. Clarke. 63 pp., 22 figs. From the series *Regionale*

[1] Head of the Department of Petroleum Engineering, University of Kansas.
Manuscript received, November 4, 1938.

Geologie der Erde. In English. Paper cover. Approx. 7×10 inches. Akademische Verlagsgesellschaft M. B. H., Leipzig. Price, RM 16.80, includes Abschnitt VI, *The Indian Peninsula and Ceylon.*

CALIFORNIA

*"Deep Zone Developments in Torrance Field," by James A. Bermingham, Jr. *California Oil World* (Los Angeles), Vol. 31, No. 19 (October 8, 1938), pp. 3–7; 6 figs.

*"Causes of Faulting and Folding on West Side of the San Joaquin Valley," by Gerard Henny. *Ibid.*, Vol. 31, No. 20 (October 27, 1938), pp. 2–4; 2 maps, 2 cross sections.

ECUADOR

*"On a Theory of Gravitational Sliding Applied to the Tertiary of Ancon, Ecuador," by C. Barrington Brown. *Quart. Jour. Geol. Soc. London*, Vol. 94, Pt. 3 (September 30, 1938), pp. 359–70; 4 figs., 5 pls.

GENERAL

Textbook of Petrology. Vol. 1, *The Petrology of the Igneous Rocks*, by F. H. Hatch and A. K. Wells. Ninth edition completely revised by A. K. Wells. "The matter has been rearranged, much of it has been rewritten, and many new illustrations have been added. . . . " 368 pp., 154 figs. Cloth. Approx. 5½×8½ inches. George Allen and Unwin, Ltd. (London, 1938). Price, $4.50. Vol. 2, *The Petrology of the Sedimentary Rocks*, by F. H. Hatch and R. H. Rastall. Third edition entirely revised by Maurice Black. This edition contains some of the results of the work of the petroleum industry in research on oil-bearing sediments and other rock groups. 383 pp., 75 figs. Cloth. Approx. 5½×8½ inches. Price, $4.25.

Practical Oil Geology, by Dorsey Hager. Fifth edition. 466 pp., 204 figs., 60 tables. Approx. 7¼×5 inches. Semi-flexible cover. McGraw-Hill Book Company, New York (1938). Price, $4.00.

**Bibliography and Index of Geology Exclusive of North America, Volume 5—1937*, by John M. Nickles, Marie Siegrist, and Eleanor Tatge. Published by the Geological Society of America, 419 W. 117 Street, New York (1938). 510 pp. Cloth.

*"Characteristics, Methods of Combating and Economic Importance of Heaving Shales," by Michel T. Halbouty and Nicolas A. Kaldenbach. *Oil Weekly* (Houston), Vol. 91, No. 7 (October 24, 1938), pp. 17–26; 1 fig., 2 pls., 1 table.

Paläogeographie und Tektonik (Paleogeography and Tectonics), by Franz Kossmat. xxiii and 414 pp., 5 pls., 30 figs. Gebrüder Borntraeger, Berlin (1938). Price, RM 20.

Steinsalz und Kalisalze Geologie (Geology of Rock Salt and Potash Salts), by Franz Lotze. Vol. 3, Pt. 1 of *Lagerstätten der Nicht-Erze* (Deposits of Non-Metallics). xxvii and 830 pp., 353 figs. Gebrüder Borntraeger, Berlin (1938). Price: cloth, RM 87.60; paper, RM 84.

Die Entwicklung der Kontinente und ihrer Lebewelt, ein Beitrag zur vergleichenden Erdgeschichte (The Evolution of the Continents and Life on Them, A Contribution to Comparative Earth History), Band 1, (2d edit.), by Theodor Arldt. 1005 pp., 61 figs. Gebrüder Borntraeger, Berlin (August, 1938). Price, cloth, RM 76.

*"Adjustments in Small-Scale Non-Concentric Folding," by H. W. Straley, III. *Bull. Geol. Soc. America* (New York), Vol. 49, No. 10 (October 1, 1938), pp. 1545–67; 10 figs.

*"Cambrian System (Restricted) of the Southern Appalachians," by Charles Elmer Resser. *Geol. Soc. America Spec. Paper 15* (October 31, 1938). 140 pp., 16 pls.

*"Utilitarian Classification for Fragmentary Fossils," by Carey Croneis. *Jour. Geol.* (Chicago), Vol. 46, No. 7 (October–November, 1938), pp. 975–84.

*"Marine Shorelines Reviewed," by John B. Lucke. *Ibid.*, pp. 985–95.

*"Classification of Marine Shorelines: a Reply," by Francis P. Shepard. *Ibid.*, pp. 996–1006.

GEOPHYSICS

*"Dichtebestimmungen an Gesteinen aus deutschen Erdölgebieten" (Density Determinations of Rocks of the German Oil Region), by Friedrich Breyer. Reprinted from *Beiträge zur angewandten Geophysik* (Potsdam), Bd. 7, Heft 3 (1938), pp. 245–59; 7 figs. *Publication 11* of the Institution of Petroleum Research of the Technical University, Hannover.

GERMANY

*"Stratigraphische und paläogeographische Untersuchungen über den Unteren Weissen Jura in der weiteren Umgebung von Braunschweig" (Investigation of the Stratigraphy and Paleogeography of the Lower White Jurassic in the Larger Environs of Braunschweig), by Wolfgang Schott. Reprinted from *Jahrbuch der Preussischen Geologischen Landesanstalt für 1937*, Bd. 58 (Berlin, 1938), pp. 698–729; 1 table, 1 folded correlation chart, 5 figs. *Publication 10* of the Institution of Petroleum Research of the Technical University, Hannover.

*"Der Westrand der Pompeckj'schen Schwelle zur Kreidezeit in Hannover" (The West Side of the Pompeckj Swell of the Cretaceous in Hannover), by Leonhard Riedel. Reprinted from *Zeitschrift der Deutschen Geologischen Gesellschaft*, Bd. 90, Heft 1 (1938), pp. 26–41; 1 map. *Publication 8* of the Institution of Petroleum Research of the Technical University, Hannover.

*"The Rhenish Schiefergebirge," by N. Tilmann and Others. *Proc. Geol. Assoc.* (London), Vol. 49, Pt. 3 (October 28, 1938), pp. 225–60; 7 figs., 2 pls. Devonian and Carboniferous rocks transgressed by Upper Cretaceous.

GREAT BRITAIN

*"The Red Measures of the Menaian Region of Carnarvonshire," by Edward Greenly. *Quart. Jour. Geol. Soc. London*, Vol. 94, Pt. 3 (September 30, 1938), pp. 331–45; 6 figs., 1 pl.

*"A Zonal Map of Parts of the South Downs," by A. J. Bull. *Proc. Geol. Assoc.* (London), Vol. 49, Pt. 3 (October 28, 1938), pp. 261–63. Contains folded map, in colors, showing paleontological zones in the Chalk of the Eastbourne District.

*"Some Episodes in the Structural Evolution of S. E. England Considered in Relation to the Concealed Boundary of Meso-Europe," by S. W. Wooldridge and D. L. Linton. *Ibid.*, pp. 264–91, includes discussion; 9 figs., 2 pls.

*"The Geology of the Country around Harrogate," by R. G. S. Hudson and Others. *Ibid.*, pp. 293–352; 6 figs. Gives subdivisions of the Carboniferous. "The Bowland Shales are rich in organic material and traces of oil are often found."

ILLINOIS

"Current Developments in Oil and Gas." *State Geol. Survey Illinois Cir. 23 B.* Seven articles, a part of the contributions of the Fifth Annual Mineral Industries Conference, are as follows: "Developments in Illinois since January 1, 1937," by Alfred H. Bell; "Oil Exploration in the Eastern Portion of the Illinois Basin," by Theron Wasson; "Water Flooding of Oil Sands," by Paul D. Torrey; "Recent Developments in Water Flooding in Illinois Oil Fields," by Frederick Squires; "State Regulation of Oil and Gas Production for the Prevention of Physical Waste," by William Bell; "Changing Legal Concepts Affecting the Oil and Gas Industry," by Walter L. Summers; "Economic Aspects of the Heating Oil Market," by Walter H. Voskuil. 90 pp. Price, gratis, postage, 4 cents.

INDIA

Die alten Kerne (The Ancient Coigns), Abschnitt VI (1938), *The Indian Peninsula and Ceylon*, by G. de P. Cotter. 72 pp., 21 figs. From the series *Regionale Geologie der Erde.* In English. Paper cover. Approx. 7×10 inches. Akademische Verlagsgesellschaft M. B. H., Leipzig. Price, RM 16.80, includes Abschnitt VII, *Middle and West Australia.*

*"The Bain Boulder-Bed: a Glacial Episode in the Siwalik Series of the Marwat Kundi Range and Shekh Budin, North-West Frontier Province, India," by T. O. Morris. *Quart. Jour. Geol. Soc. London*, Vol. 94, Pt. 3 (September 30, 1938), pp. 385–421; 9 figs., 2 pls., 2 geological maps, 2 cross sections, columnar sections.

KANSAS

*"Geology and Oil and Gas Resources of Rush County," by Kenneth K. Landes and Raymond P. Keroher. *Bull. Univ. Kansas* (Lawrence), Vol. 39, No. 12 (June 15, 1938), *Min. Resources Cir. 4.* 31 pp., 2 pls., 4 figs., including maps and cross sections. Contains list of wells completed in the county.

*"Geology and Coal Resources of the Southeastern Kansas Coal Field in Crawford, Cherokee and Labette Counties," by W. G. Pierce and W. H. Courtier, with a report on "Pennsylvanian Invertebrate Faunas of Southeastern Kansas," by James Williams. *Bull. Univ. Kansas* (Lawrence), Vol. 38, No. 14 (July 15, 1937, printed, 1938), *State Geol. Survey Kansas Bull. 24.* 122 pp., 12 pls., 13 figs. Contains geological map of southeastern Kansas coal field and a structure map in pocket.

LOUISIANA

*"Origin of the Cap Rock of Louisiana Salt Domes," by Ralph E. Taylor. *Louisiana Geol. Survey Bull. 11* (New Orleans, August, 1938). 191 pp., 4 figs., 27 pls., 1 map in pocket, showing the location of salt domes and the material produced from each.

MEXICO

*"Descripción Geológica de la Región Comprendida entre los Pueblos de Xilitla, Axtla, Cómoca y La Y Griega, S. L. P." (Geologic Description of the Region between Xilitla, Axtla, Cómoca, and La Y Griega, San Luis Potosí), by Edmundo Cepeda. *Ingeniería* (Mexico City), Vol. 12, No 10 (October, 1938), pp. 372–77; 5 figs.

NEW GUINEA AND PAPUA

*"The Occurrence of *Lacazina* and *Biplanispira* in the Mandated Territory of New Guinea," by Irene Crespin. *Commonwealth of Australia Palaeon. Bull. 3* (Canberra, August, 1938), pp. 1–8; 2 pls.

*"A Lower Miocene Limestone from the Ok Ti River, Papua," by Irene Crespin. *Ibid.*, pp. 9–16; 1 pl., 1 map.

NEW MEXICO

*"Tertiary Geology of the Abiquiu Quadrangle, New Mexico," by Harold T. U. Smith. *Jour. Geol.* (Chicago), Vol. 46, No. 7 (October–November, 1938), pp. 933–65; 12 figs.

PERU

*"Slip-Planes and Breccia Zones in the Tertiary Rocks of Peru," by R. A. Baldry. *Quart. Jour. Geol. Soc. London*, Vol. 94, Pt. 3 (September 30, 1938), pp. 347–58; 6 figs., 5 pls.

RUSSIA

"Possibilities of Petroleum Deposits in the Western Urals," by D. M. Preda. *Monit. Petrol. Roum.*, Vol. 39 (1938), pp. 685–87. *Abstract in *Jour. Inst. Petrol. Tech.*, Vol. 24, No. 179 (September, 1938), p. 348A.

WYOMING

*"Structure of the Southwest Margin of the Laramie Basin, Wyoming," by R. H. Beckwith. *Bull. Geol. Soc. America* (New York), Vol. 49, No. 10 (October 1, 1938), pp. 1515–44; 1 pl., 2 figs.

BULLETIN OF THE AMERICAN ASSOCIATION OF PETROLEUM GEOLOGISTS
VOL. 22, NO. 12 (DECEMBER, 1938), PP. 1698-1719

THE ASSOCIATION ROUND TABLE

EDITORIAL

THIRTY-YEAR OIL FIELDS

WALLACE E. PRATT
New York City

Mr. L. P. Garrett, during his presidency of the Association, outlined a conservation program for crude-oil producers at once so pertinent and so simple as to inspire the immediate comment, "industrial statesmanship."

Although he laid down no precise formula, Mr. Garrett sketched a plan, the objective of which may be stated as the maximum ultimate recovery from each oil field, commensurate with low unit costs. The same objective would be closely approached if the aim were to obtain the lowest average unit costs over the life of the oil field, commensurate with efficient oil recovery. In either case the imperative consideration would be to make the fullest use of the natural reservoir energy, whether it were the expansion of dissolved or free gas, or the hydraulic pressure of edge and bottom water, or any combination of these factors.

Probably the most important factor in increasing the efficiency of our use of reservoir energy is the reduction in the rate at which we withdraw oil from its natural reservoir. Mr. T. V. Moore has explained the function of slow withdrawal of the fluid content of oil and gas reservoirs with great clarity in the September, 1938, *Bulletin*. Obliged by drastic proration schedules to reduce further and further our rates of withdrawal, we have finally come to realize that a sufficiently low rate will permit many fields to yield their oil with practically no depletion of reservoir energy. In such fields, bottom-hole pressures, our best index of reservoir energy levels, will maintain themselves almost at their initial value until after the last barrel of recoverable oil has come to the surface. Viewed in the light of our old production practices this is an arresting realization.

Obviously, more oil may be withdrawn without waste in a given period from a reservoir with large reserves than from a small reserve, although the relationship of withdrawal rate to reserve is not rigid or constant. The records of the Railroad Commission of Texas contain the sworn testimony of experts as to the rates at which a number of important oil fields can produce without physical waste. East Texas, with an original reserve usually estimated at 3.5 billion barrels, or so, can be produced without physical waste at a rate not to exceed about 400 thousand barrels of fluid (oil and water) daily, according to convincing testimony of a number of competent engineers. Similarly, Yates, with original reserves of 0.75 billion barrels, is adjudged capable of a production of about 80 thousand barrels a day without waste. Conroe, with 600 thousand barrels original reserves, more or less, can safely produce 70 thousand barrels, or so, daily. Sugarland, with original reserves estimated at 65 million barrels, or more, can produce without waste at a maximum rate estimated at about 6 thousand barrels daily. Thompson, with original reserves estimated at more than 200 million, is believed to be capable of producing 20 thousand barrels daily without physical waste. Both Sugarland and Thomp-

son have been producing for years (Sugarland more than 10 years) and each has flowed millions of barrels of oil; yet their present bottom-hole pressures are practically the same as the original reservoir pressures. If these fields continue to be produced at the prescribed rates they should show almost no production decline with age. Practically speaking, their last days' production would be at the average rate.

The fields here cited are "water-drive" fields, that is, under hydraulic control. Reservoirs with large volumes of dissolved gas, or with gas caps (fields under volumetric control), can not be made to yield their oil without some loss of energy, and consequent reduction of bottom-hole pressures. But if the gas produced with the oil is returned to the sand by recycling, the fall in bottom-hole pressure is proportionally small. Incidentally, the cost of recycling gas, as a method of producing oil, is only a fraction of the cost of the old style pumping, provided the field outlet is reasonably restricted.

The foregoing estimates of rates at which Texas fields can be produced without waste indicate an average daily producing rate of one barrel for each 7 thousand to 10 thousand barrels of initial reserves. This rate means a life span of 25–30 years for such fields. Other fields, which yield their oil less freely, might require an even longer exploitation period for most efficient production.

Practical operators will protest at the suggestion that oil fields be exploited over a period of 30 years. They will contend that interest on the investment will eat up the profits because of the long deferred return. The answer is that the increased recovery that may reasonably be expected from this most efficient producing practice will more than compensate for the costs of deferred returns.

About two-thirds of the current oil production in the United States comes from flush fields in which are to be found only a little more than two-thirds of the estimated oil reserves of the United States. In these fields, then, the average producing rate is about double the most efficient rate for the average oil field. In spite of potential production in excess of current market demand it appears that we could still do with our present volume of reserves, or an even larger reserve, if we were to produce our oil uniformly from all fields at the most efficient rate.

MEMBERSHIP APPLICATIONS APPROVED FOR PUBLICATION

The executive committee has approved for publication the names of the following candidates for membership in the Association. This does not constitute an election but places the names before the membership at large. If any member has information bearing on the qualifications of these nominees, he should send it promptly to the Executive Committee, Box 979, Tulsa, Oklahoma. (Names of sponsors are placed beneath the name of each nominee.)

FOR ACTIVE MEMBERSHIP

Albert Leo Ladner, Houston, Tex.
Louis A. Scholl, Jr., J. N. Troxell, John C. Miller

Augustin Pyre, Ciudad Bolivar, Venezuela, S. A.
P. E. Nolan, E. E. Brossard, Hollis D. Hedberg

FOR ASSOCIATE MEMBERSHIP

Allan Dexter Graves, Puerto Wilches, Santander, Colombia
Benjamin B. Cox, C. S. Corbett, George S. Hume
Robert Frederick Meyer, Wichita, Kan.
Edward A. Koester, Harold O. Smedley, James I. Daniels
Carl Allphin Moore, Iowa City, Iowa
A. I. Levorsen, A. N. Murray, A. C. Trowbridge
Sam Henry Stith, Jr., Lexington, Ky.
Daniel J. Jones, Arthur C. McFarlan, Arthur C. Munyan
Robert Paul Teten, Oklahoma City, Okla.
Kenneth A. Ellison, Hubert E. Bale, Richard W. Camp

FOR TRANSFER TO ACTIVE MEMBERSHIP

Flint H. Agee, Huntington Park, Calif.
O. E. Walton, George C. McGhee, A. E. McKay
Harold Denton, Beaumont, Tex.
R. W. Pack, Donald D. Braugh, L. W. Storm
Jean Edward Joujon-Roche, Bakersfield, Calif.
E. F. Davis, F. E. Vaughan, W. Hafner
James Holland McGuirt, University, La.
Henry V. Howe, R. G. Ryan, A. F. Crider
Frank Oliver Mortlock, Pittsburgh, Pa.
E. A. Eckhardt, R. W. Clark, A. G. Nance
Russell Spurgeon Poor, Birmingham, Ala.
M. M. Leighton, Harold R. Wanless, A. N. Murray
Fred C. Shields, Oklahoma City, Okla.
John E. Van Dall, S. A. Thompson, V. G. Hill
Loring Bertram Snedden, Ventura, Calif.
Albert Gregersen, Chester Cassel, H. J. Steiny

(Continued on page 1718)

TWENTY-FOURTH ANNUAL MEETING, OKLAHOMA CITY, MARCH 22–24, 1939

The following committee chairmen have been appointed and are making arrangements for the twenty-fourth annual meeting of the Association at Oklahoma City, March 22–24, 1939. For greater convenience plans have been changed about meeting places and the Skirvin Hotel is designated as convention headquarters. The technical program, exhibits, committee meetings, and dinner dance will be at the Skirvin.

Committee in charge

R. W. Laughlin, general chairman, Laughlin-Simmons Company, Box 383
J. T. Richards, chairman of technical program, Gulf Oil Corporation, Box 1557
John E. Van Dall, vice-chairman of arrangements, Magnolia Petroleum Corporation, Box 1828

Entertainment

Jerry B. Newby, consulting, 1816 NW. 23rd Street

Field Trips

Robert H. Dott, Oklahoma Geological Survey, Norman

Golf

Roy Dale Jones, Ardie Oil and Gas Company, 342 Key Building

Publicity

Richard W. Camp, Consolidated Gas Utilities Corporation, Hales Building

Reception-Registration

D. A. McGee, Kerlyn Oil Company, 2009 First National Building

Technical

E. A. Paschal, Coline Oil Corporation, 1012 Tradesmen's National Bank Building

---

MID-YEAR MEETING, EL PASO, SEPTEMBER 27–OCTOBER 2, 1938

ABSTRACTS

The West Texas Geological Society of Midland arranged the technical program of twenty-one papers on the geology of West Texas and southeastern New Mexico and entertained the Association at the mid-year meeting in El Paso, 300 miles distant, with the aid of the South Texas Geological Society, the El Paso Chapter of the American Institute of Mining and Metallurgical Engineers, the New Mexico Geological Society, and the faculties of the College of Mines and Metallurgy at El Paso, and the New Mexico School of Mines at Socorro. The total registration of geologists, wives, and friends was 386, a new high attendance for mid-year meetings, according to convention records. Of this number, 206 were members and associates; 75 were non-member women; and 105 were non-member men. The several committees under the active general chairmanship of Berte R. Haigh were listed in the August *Bulletin*, and the five field trips, covering three very full days before and after the 2-day technical program, were also outlined in that issue. However, the previously planned Chihuahua, Mexico, trip was cancelled and another metal-mining excursion was substituted,—to the Silver City district of New Mexico.

The distance of several hundred miles from Midland, the home of the sponsoring society, to El Paso, the convention city, seemed no apparent handicap to the efficiency of the arrangement committees but to those who know something of the responsibilities of local committees, it seemed that the 7-league legs of even so energetic a general chairman as Berte Haigh must have been severely stretched at times in that region of desert distances.

Several innovations marked the mechanical presentation of the technical papers. The printed program contained a 2-page regional index map and a full-page stratigraphic correlation chart so that the reader could locate the subject matter of each paper by convenient key numbers. The presentation of illustrations was facilitated by the use of two projection lanterns and two screens, one screen permitting the continuous display of a regional map while the other alongside it was being used for a series of detailed flashes that could be readily tied into the regional picture. In addition to the two projectors for transparent slides, a reflecting lantern was in use for opaque illustrations. The chairman, or master of ceremonies, sat at one side of the rostrum, using the

sound amplifying system to make announcements and to introduce speakers without unnecessary loss of time and detraction from the scientific subject matter. The chest microphone was demonstrated as a distinct aid. Such devices, well planned by the technical program committee, provide the speaker with more time and ease in presenting his subject and more satisfaction for the listeners.

The technical session opened at 9:30 A.M., September 29, in the Crystal Ballroom of the Hotel Cortez. General chairman Haigh presided and M. A. Harlan, mayor of El Paso, welcomed the convention. H. A. Hemphill responded in behalf of the West Texas Geological Society and Donald C. Barton responded in behalf of the Association. It is planned to publish the papers as a New Mexico-West Texas Permian Basin symposium in the Association *Bulletin* as soon as the manuscripts are completed.

1. ED W. OWEN, geologist, L. H. Wentz Oil Division, San Antonio: Summary of Regional Geology and Oil Development of the West Texas Permian Basin.

2. JAMES FITZGERALD, JR., division manager, lands and leases, Skelly Oil Company, Midland, presenting the following two cross sections.

2a. W. C. FRITZ, geologist, Skelly Oil Company, Midland: South-North Cross Section from Pecos County through Ector County, Texas, to Roosevelt County, New Mexico (abstract).

The section extending from Shell-Kirby University No. 1 in central Pecos County, Texas, to Franklin Gephart No. 1 in northern Roosevelt County, New Mexico, is carried generally along the eastern part of the Central Basin platform. It traverses most of the upper Castile basin of deposition and shows its northern limit. Through Crane, Ector and Andrews counties, the cross section is along the strike of the beds of the Whitehorse formation. It shows the progressively increasing depth of the porous and producing zones from the Whitehorse formation into the San Andres formation, although the only oil wells shown on the section are producing from the San Andres or older formations. Some idea of the magnitude of the unconformity at the base of the Permian is indicated in the first ten wells in the section. The suspected relationship of the Glorieta (base of San Andres) with the undifferentiated Permian of the southern part of the Central Basin platform is also shown.

2b. E. HAZEN WOODS, geologist, Sinclair Prairie Oil Company, Midland: South-North Cross Section from Pecos County through Winkler County, Texas, to Roosevelt County, New Mexico.

The section extends from Shell-Kirby University No. 1 in Pecos County to Sloan & Smith Lovern No. 1 in Roosevelt County, New Mexico. The first eighteen wells along the western part of the Central Basin platform show the generally accepted interpretation of reef production in the Whitehorse formation of Ward and Winkler counties, Texas, and southeastern Lea County, New Mexico. The section shows also the reef and the lagoonal facies of the Whitehorse and attendant production. North of the Vacuum pool of Lea County, the transition from predominantly dolomitic deposition to the broken anhydrite, salt and sand facies of the Whitehorse and San Andres formations in Roosevelt County, New Mexico, is shown.

3. ROBERT I. DICKEY, geologist, Stanolind Oil and Gas Company, Mid-

land: Geologic Section from Fisher County through Andrews County, Texas, to Eddy County, New Mexico.

The geologic section presented herewith has been compiled from sample logs of the West Texas-New Mexico Permian basin. It shows chiefly the continuity of the formations of the Whitehorse group from the east side to the west side of the basin. The gradation of sediments in the San Andres and Clear Fork from a shale and evaporite section on the east-side outcrop to an almost solid dolomite section in the subsurface in the basin is brought out by the large scale of the section and detailed character of the logs. In addition, the thicknesses of the formations are shown and the depths to producing strata in the basin.

4. E. H. SELLARDS, director, Bureau of Economic Geology, Austin, Texas: Early Paleozoic Formations in Texas.

The purpose of this paper is to summarize the available data derived from surface exposures and drilling records as to the extent of early Paleozoic seas in Texas. The first Paleozoic sea to invade Texas, so far as known, was that of Upper Cambrian time. This sea spread widely across central Texas, occupying a seaway extending from Oklahoma southwestward to El Paso. The Lower Ordovician sea occupied a similar seaway and may have extended somewhat more widely to the northwest. The Middle Ordovician sea covered at least the southern part of the Permian basin and probably connected through the Llanoria geosyncline with the Ouachita region of Oklahoma. The Upper Ordovician sea occupied the Llanoria geosyncline and a large part of trans-Pecos Texas. A Silurian sea is believed to have extended into northeast Texas, lying in the Llanoria geosyncline. A Silurian sea likewise submerged the Diablo Plateau-El Paso region of trans-Pecos Texas. Evidence is lacking to prove the connection of the two seas across Texas. A Devonian sea is believed to have extended across Texas, occupying the Llanoria geosyncline.

Starting with an emergent condition at the beginning of Paleozoic time, the major changes of Paleozoic time in the Texas region are: submergence through Cambrian, with maximum submergence in Lower Ordovician; emergence through Middle and Upper Ordovician, with maximum emergence in Silurian; submergence in Devonian and Mississippian, with maximum submergence about Upper Pennsylvanian; emergence reaching maximum at close of Permian or in Triassic.

5. M. G. CHENEY, consulting geologist, Coleman, Texas: Geology of North-Central and Central Texas.

Cross sections and maps reveal the Concho arch as an imposing northwest trending structural feature, denuded in the Llano uplift area. The similarity of this arch to the Central Kansas uplift would be more obvious except for greater westward tilting of the Texas area. As in central Kansas, a comparatively thin Pennsylvanian section rests on truncated Ordovician and older beds along this broad axis. Uplift and erosion of the Ordovician evidently began during pre-Mississippian time. The Bend, and, to a greater degree, the Millsap Lake, Garner, and Mineral Wells beds show both pronounced thinning and some truncation over this broad regional feature.

Attention is also given to the evidence of progressive development of the Ouachita-Marathon mountains, the Electra and Muenster arches, the Bend flexure and other large structural features of this region.

Because of the possible economic importance of the arched Ordovician beds, the identification of subdivisions by insoluble residues and general character of well cuttings has been attempted with encouraging results.

To facilitate correlation of the Pennsylvanian and Lower Permian strata, a classification by "subseries" as in the northern Mid-Continent and West Texas regions has been used in this paper. Such procedure places emphasis on unconformities and faunal changes of wide regional importance. Former group names are retained but boundaries redefined where needed.

The probable influence of the regional conditions in this area upon oil and gas migration and accumulation is discussed, such as the overlap of structurally high reservoirs by apparent source beds; differential pressures resulting from wedge-shaped overburden; progressive development of structural trends and local folds; and the character and distribution of sedimentary material, especially the development of local sandstone or limestone reservoirs and stratigraphic traps.

6. ELLIOT H. POWERS, geologist, Gulf Oil Corporation, Midland: Sand Hills Area, Western Crane County, Texas.

The Sand Hills area of western Crane County includes two pools, the Tubb and McKnight, in which production is obtained from Permian dolomite. In a third small area on the northwest side of the Tubb pool, three wells have encountered flush production of high-gravity oil in the upper portion of the Lower Ordovician dolomite, and two small wells produce from a sandstone member of the Simpson, having failed in the Lower Ordovician.

Lower Permian dolomite lies unconformably on the eroded surface of a seemingly complex structural system, which involves Lower and Middle Ordovician sediments. Intermediate beds of probably Upper Ordovician, Silurian, and Devonian ages, respectively, appear in a test which was drilled approximately eight miles southeast of the Ordovician producing area.

7. L. A. NELSON, associate professor of geology, College of Mines and Metallurgy, El Paso: Paleozoic Stratigraphy of the Franklin Mountains of West Texas.

The Franklin Mountains are located within a region that is bounded on the east by longitude 104°30′ W., on the west by longitude 109° W., on the south approximately by latitude 31° N., on the north approximately by latitude 34° N. From just north of El Paso the Franklin Range trends almost parallel with the 106°30′ meridian to a point about 4 miles north of the Texas-New Mexico boundary line.

The Franklin Mountains are eroded block mountains typical of the basin-and-range structure of the southwestern United States. The west side is a steep dip slope developed principally on beds of limestone. The east side is a fault scarp.

The Paleozoic stratigraphic section, which aggregates 5,600–7,000 feet in thickness, is as follows: Permian, Wolfcamp formation; Pennsylvanian, Magdalena formation; Mississippian, Helms formation; Devonian, Canutillo formation; Silurian, Fusselman limestone; Ordovician, Montoya and El Paso limestones; Cambrian, Bliss sandstone. The section is overlain by the Comanche and rests, in places, on pre-Cambrian granite and at other places on the Llanoria quartzite.

The exposed portion of the Magdalena formation consists primarily of thin-bedded, light gray to black limestone, and for convenience it is divided into the following three units: the La Tuna at the base, the Berino, and the Bishop's Cap at the top.

Comparatively few fossils have been reported from the near-by localities; hence it is difficult to use them to correlate the Magdalena of the Franklin Mountains with formations in these areas. A few closely allied genera and species of gastropods and brachiopods are reported from the Taos region of northern New Mexico and from the McCoy region and the Mosquito Range of Colorado. However, the most striking similarity is to a gastropod fauna described from the St. Louis outlier of Missouri and the equivalent St. David's limestone of Illinois.

The Permian is represented by about 650 feet of exposed sediments known as the Wolfcamp. These sediments occur as outliers some distance west of the Franklin Range and are separated from the exposed Magdalena sediments by alluvial deposits; hence the contact between the Magdalena and the Wolfcamp has not been seen.

8. C. E. NEEDHAM, associate professor of geology, School of Mines, Socorro, New Mexico: Correlation of the Pennsylvanian Rocks of New Mexico.

A typical section of Pennsylvanian rocks in central New Mexico is 1,500–1,800 feet thick. The lowest beds lie below the zone of *Triticites* and *Wedekindellina* and contain *Chaetetes milleporaceous*, *Spirifer rockymontanus*, *Spirifer occidentalis*, *Cleiothyridina orbicularis*, and *Mesolobus mesolobus*. These beds are considered to be younger than Bend, Morrow, or lower Pottsville, and are believed to correlate with the lower Cherokee, lower Atoka, upper Dornick Hills, lower Deese, lower Millsap Lake, lower Hartville, upper Pottsville, and lower Allegheny.

The zone above contains *Fusulina euryteines*, *Wedekindellina euthysepta*, *Wedekindellina excentrica*, *Chaetetes milleporaceous*, *Cleiothyridina orbicularis*, and *Mesolobus mesolobus*. These beds are correlated with the upper Cherokee, McCoy, upper Hermosa, middle Hartville, upper Millsap Lake, middle Haymond, upper Atoka, middle Deese, Boggy, Wetumka, Carbondale, and upper Allegheny. The equivalent of the Marmaton and Wewoka has not been recognized but is believed to be present.

The succeeding zone is the equivalent of the Kansas City and Lansing, upper Hartville, middle Canyon, middle Gaptank, middle Hoxbar, and lower Conemaugh. It is characterized by *Triticites nebraskensis*, *Echinoconchus semipunctatus*, and *Neospirifer latus*.

Next above is a zone containing numerous advanced species of *Triticites*, *Enteletes hemiplicatus*, *Marginifera hystricula*, and *Chonetes transversalis*. This zone is the equivalent of the lower Virgil, lower Cisco, upper Gaptank, and Vamoosa. Finally, the highest Pennsylvanian beds in New Mexico contain *Triticites ventricosus* and are probably the equivalent of at least a part of the Wabaunsee and the upper part of the lower Cisco.

9. JOHN W. SKINNER, geologist, Humble Oil and Refining Company, Midland: The Upper Paleozoic Section of the Chinati Mountains, Presidio County, Texas.

Previous work in the Chinati Mountains is briefly reviewed and the various exposures of Paleozoic sediments are described. The stratigraphy is dis-

cussed and evidence is presented demonstrating the presence of a Permian section nearly as complete as that of the Glass Mountains, as well as a fairly complete Pennsylvanian sequence.

10. LOUIS V. OLSON, assistant director, Agricultural Research Department, American Smelting and Refining Company, El Paso: Aerial Photography for Geological Exploration.

The use of aerial photographs has gradually increased until at the present time no important surface geological work or any other surface exploration work, such as for power lines, canals, or pipe lines, is undertaken without the preliminary of an aerial survey. The sensitivity of the modern photographic materials is such that by the proper use of light filters slight color changes may be detected denoting changes of bedding planes which could not be detected by the eye. Stereoscopes have been developed that make it possible to detect even minor changes in elevation. Sketching of contours on the photograph tends to eliminate laborious ground survey work. Of course, the stereoscope also indicates the relative hardness of adjacent terrain, which is very important in tracing rock formation.

11. CARY P. BUTCHER, geologist, Tide Water Associated Oil Company, Midland: The Guadalupe Mountains as They Look to the Aerial Geologist.

Stratigraphy in the Guadalupe Mountains is definitely related to contemporaneous structural movements. These relationships become obvious to the aerial observer. They become a part of his permanent record when they are photographed. Initial ground reconnaissance is advisable, and subsurface data should be given careful consideration. Such procedure has been followed in the Guadalupe area. Aerial observation is of great value even prior to surface or subsurface study. Thus time is saved, especially as the observer gains in experience. Hence these progressive aerial obliques of the Guadalupe Mountains are presented in the hope that they will be of value in better understanding subsequent papers and field trips. They culminate work begun in 1928. Views are east-northeast, and the progression is in a northwesterly direction. A simple cross section is added in further explanation.

12. RONALD K. DEFORD, geologist, Argo Oil Corporation, Midland, GEO. D. RIGGS, consulting geologist, and NEIL H. WILLS, consulting geologist, Carlsbad, New Mexico: Surface and Subsurface Formations, Eddy County, New Mexico.

This is a preliminary report on incomplete surface and subsurface studies in Eddy County and adjacent areas. Results so far are as follows.

The Yates sand has been traced from subsurface into the surface outcrop, and the top of the Yates mapped from Carlsbad to McKittrick Canyon.

The subdivision of the Whitehorse-Capitan is simplified, making it more suitable for daily use by subsurface (and also field) geologists. From top downward it is subdivided into Carlsbad, Yates, Seven Rivers, Queen. This involves redefinition of the Carlsbad.

The gradation of Whitehorse into Capitan disposes of the untenable theory that the Whitehorse is Triassic. Yates sand passes beneath beds containing Permian (Guadalupian) fossils.

Even the youngest Carlsbad grades laterally into massive Capitan limestone, and all the Capitan limestone grades into the upper 800 feet of the

Delaware Mountain sandstone. The Lower Castile formation is younger than the Capitan, which it overlaps.

In the vicinity of Carlsbad the Rustler rests directly on the Carlsbad limestone. Evidence of the Pleistocene age of the Pierce Canyon beds is presented.

13. GEORGE A. KROENLEIN, geologist, Lovington, New Mexico: Salt, Potash, and Anhydrite in the Castile Formation of Southeast New Mexico.

Continual accumulation of concentrated saline water beneath the surface water in the Delaware basin raised the level of the highly concentrated water to the point where it caused two epoch-making events to occur in Upper Permian history. First, it stopped Capitan reef building and associated petroleum deposition. Second, it diminished the inflow of marine water and started deposition of evaporites in the Delaware basin. This point marks the close of Capitan time and the beginning of Castile time.

Subsurface study of the lower Castile formation discloses many hundred feet of depositional relief on the basin floor. This condition is responsible for unsuccessful attempts to run a structural correlation across the Delaware Basin on the base of the upper Castile (Main Salt).

At present, potash is the mineral with greatest economic importance in the Castile formation. Two mines are producing from one of the finest potash deposits in the world.

Two subsurface cross sections show many interesting features about the deposition and occurrence of evaporites.

14. PHILIP B. KING, associate geologist, Geological Survey, U. S. Department of Interior, Washington, D. C.: Relation of Permian Sedimentation to Tectonics in Guadalupe Mountain Region.

This paper is based on observations in the areas of Permian outcrop of northern trans-Pecos Texas, and especially in the Guadalupe Mountains and the Sierra Diablo. The two regions are mutually supplementary in that the first exposes the higher Permian and the second the Lower Permian and pre-Permian rocks.

The stratigraphy of the Permian series is complex, for it is characterized by great and abrupt changes in faunal and lithologic facies and in thickness of beds. The most striking features are limestone reefs, of which one of the largest is formed by the Capitan limestone. These are thicker and less elastic than adjacent contemporaneous deposits. Other less striking but no less significant changes are common, including lateral gradation of limestone into clastic rocks or evaporites, and of one variety of limestone into another.

These complex relations were produced by variations from place to place of physical-chemical and ecological environments at the inner end of an embayment of the sea. The variations resulted from many causes, the relative importance of which is not easy to evaluate. Some barriers, such as the reef masses, produced largely by sedimentation, restricted the inwash of clastic sediments and caused differences in depth and salinity on opposing sides. Similar effects have been caused by buried hills that are erosional relics of pre-Permian disturbances. The author believes, however, that some structural features arising on the sea floor during Permian sedimentation were also the direct cause of variations in environment and that they were an indirect cause of variations by their effect on the placing of the reefs and hills. The fundamental control of the complex Permian deposits thus appears to be tectonic.

Tectonic control has been imparted in a broad way by differences in subsidence in different areas and, on a smaller scale, by monoclinal flexures that were in movement during the time of Permian deposition.

Control by differential subsidence is illustrated by the relation of the Permian rocks of the Delaware basin to those in adjacent areas. The northwest corner of the former basin extends into the now upraised mountain area, and was bordered on the west by an area that may be termed the Diablo platform, a part of which forms the present Sierra Diablo. The platform has a substructure of deformed and deeply eroded pre-Permian Paleozoic and of pre-Paleozoic rocks, but the basin may have been a region of little disturbance during pre-Permian time, for the few deep wells that have gone beneath the Permian in the basin show that it rests on little disturbed later Pennsylvanian rocks.

That the basin was a region of greater subsidence than the platform during early Permian time is suggested by the thinning of the Bone Spring and other early Permian formations from the basin toward the platform. In later Permian time, greater subsidence of the basin may have continued, but, if so, it was now complicated by other factors. The upper Delaware Mountain deposits of the basin are thinner than equivalent beds outside the basin. Evidence indicates that they were deposited in water of great depth (1,000 feet or more). Since at this time the basin was encircled by limestone reef barriers, the inwash of clastics from outside was slow, perhaps too slow to keep pace with sinking, thus allowing the bottom to be deepened.

Control of Permian sedimentation by tectonic features is illustrated on a smaller scale by the relations near monoclinal flexures, such as the Bone Spring flexure in the Guadalupe Mountains and the Victorio flexure (named for Victorio Peak, south of which it extends) in the Sierra Diablo. On each, Permian rocks are bent down, away from the marginal area and toward the Delaware basin area, the total displacement amounting to 1,000 feet or more. The Bone Spring flexure trends north-northeast, whereas the Victorio flexure and some similar features of the Sierra Diablo trend west-northwest. Both run across the more northerly and younger Cordilleran fault and fold trends, and in the Guadalupe Mountains no faults or joints trend parallel with the Bone Spring flexure. In the Sierra Diablo, however, the Victorio flexure is paralleled by the dominant joint set of the area and by a system of faults which moved in Cenozoic and several older times. As shown by exposures, the Victorio flexure involves not only the Permian but also the pre-Permian rocks. Along it, in places, the pre-Permian rocks rise into buried hills.

The Victorio flexure is beveled by and is older than Cretaceous rocks. Movement on it during Bone Spring time is suggested by the occurrence on it in that formation of intraformational pebble conglomerates of considerable thickness. Movement on the Bone Spring flexure during Permian time is suggested by the coarse conglomerate which locally rests on the Bone Spring limestone and forms the base of the Delaware Mountain formation, and by the overlapping out of 1,000 feet of Delaware Mountain strata against the surface of the Bone Spring limestone as upraised along the flexure. The two flexures and other related features seem to have been narrow zones of interplay between the more rapidly subsiding Delaware basin area and the less rapidly subsiding platform areas.

The region of the flexures is marked by great changes in facies in the Per-

mian rocks. The facies of the Delaware basin (black shaly limestone in the Bone Spring, sandstone in the Delaware Mountain formation) gives place up the flexures to thick bedded limestones, and to massive reefs such as the Capitan limestone. It is believed that movements on the flexures aided in creating physical-chemical and ecological conditions on the sea bottom which were more favorable for lime deposition on the upper part of the flexures than the lower. Such conditions include shallower, warmer, and more agitated water, in which the solubility of calcium carbonate was reduced, and in which reef-dwelling organisms could thrive.

(Published by permission of the director, Geological Survey, U. S. Department of Interior.)

15. E. Russell Lloyd, consulting geologist, Midland: Theory of Reef Barriers.

Studies of the organic reefs of the Permian basin and their relationships to rocks of contemporaneous age show a pronounced threefold facies, which the writer proposes to call the reef facies, the lagoonal facies and the "pontic" facies, the latter being a new name proposed for the facies group of which the Delaware Mountain formation, the black shales of the Black Shale basin, the Bone Spring formation of the Delaware basin, and the type Leonard formation (not including the Hess facies) of the Glass Mountains are good examples. The reefs form natural barriers, separating the rocks of pontic facies from the sharply contrasted lagoonal facies which, in the Permian basin, consist of dolomitic limestones grading laterally into anhydrite and rock salt.

By analogy, the reef barriers may serve as adequate explanation of the origin of all thick salt and anhydrite (or gypsum) deposits such as the New York salt and gypsum deposits, the thick salt deposits of western Colorado, the Stassfurt salt deposits of Germany, and many others. In each case we should expect a lateral gradation from the salt and gypsum (or anhydrite) into dolomitic limestone.

Likewise, reef barriers may be the explanation for such contrasts as the early Paleozoic Ouachita facies (pontic facies) of the Ouachita Mountains with the contemporaneous, dominantly limestone facies (lagoonal) of the Arbuckle Mountains. In like manner, the Ordovician Marathon facies (pontic) may be separated by a reef barrier from the contemporaneous foreland (lagoonal) facies.

Similarly, a reef barrier rather than a permanent land barrier may account for the contrast between deposits of the Chazy trough (lagoonal facies) and the Levis trough (pontic facies) of the Appalachian geosyncline.

16. Lincoln R. Page, associate professor, Department of Geology, University of Colorado, Boulder, Colorado, and John Emery Adams, geologist, Standard Oil Company of Texas, Midland: Stratigraphy, Eastern Midland Basin, Texas.

The thick series of Red-beds along the eastern edge of the Southern Permian basin is divided into groups and formations that can be recognized both on the outcrops and in the subsurface. Gradations between near-shore, marine and restricted sea deposits are recognized and described, and unconformities in the section are traced out into the basin. The Triassic-Permian boundary line is redefined as occurring between the top of the newly defined Dewey Lake Red-beds and the base of the overlying Tecovas silts.

17. TAYLOR COLE, geologist, University Lands, Midland: The Black Shale Basin of West Texas; A Preliminary Report.

The Black Shale basin of West Texas covers an area in excess of 21,000 square miles and includes the region from Terrell and Pecos counties eastward to Menard and Kimble counties. It extends from Real, Edwards, and Val Verde northward beyond Glasscock and Upton counties. This basin includes such local basins as the Midland basin, the Val Verde basin of Frank E. Lewis, the Sheffield channel, and the Kerr basin.

Reasons are given for the belief that the black shale sediments in this basin were derived from rocks south of this area.

The shale ranges in age from Bend (Lower Pennsylvanian) through Clear Fork (Middle Permian). The shale of the Midland basin has been divided into three distinct zones.

Pre-Cretaceous erosion has removed the overlapping Permian shale in the extreme southern portion of the area, leaving Pennsylvanian directly beneath the Trinity (basal Cretaceous).

The problem of stratigraphy is complicated by gradation and lack of diagnostic fossils with a short vertical range. There is a great divergence of opinion, derived from the study of well cuttings, as to correlative formational units.

18. FRANK E. LEWIS, consulting geologist, Midland: Stratigraphy of the Upper and Middle Permian of West Texas and Southeast New Mexico.

The stratigraphic phenomena of the Permian basin are related directly to gradation which may be classified as follows: (1) gradual gradation of clastics into marine beds basinward and (2) abrupt gradation of clastics and evaporites into reef limestone. Surface studies and subsurface work with stereograms and paleogeographic maps reveal that, as a result of this gradation, many of the various facies are time equivalents. A significant example of type (2) gradation is found in the Glass Mountains approximately five miles north of Iron Mountain. The clastics of the Word formation may be traced on the surface into the Vidrio limestone. Over a considerable area northeast of the Glass Mountains variable thicknesses of Vidrio limestone and underlying thick sandstones both grade into San Andres limestone over structurally high areas.

The appearance, subsequent movements and disappearance of a number of the structural features are placed in the Permian time scale. Recognized as major structures are the Val Verde basin, the Cerf basin and the Blackstone arch. The latter extends northward from southeastern Pecos County across the Sheffield channel and the Fort Stockton arch into the Sand Hills arch. The Central Basin platform was built over this feature. A perspective of the Permian basin in its entirety indicates that the Anadarko basin is an integral part of the larger basin on the south.

During San Andres time sands moved into the Midland basin by way of the Sheffield channel which connected with the Delaware and Cerf basins. It appears that the sands moving into the Delaware basin came from the west through Salt Flat, which is just west of the Delaware Mountains. Throughout all Permian time red clastics, which were derived from the northwest, northeast, and east, were deposited in the northern part of the basin, the dark sediments of southern origin forming in the south portion.

The presence of facies in the South Plains syncline and the Midland basin similar to those of Oklahoma led to the adoption of Oklahoma nomenclature in West Texas. It is used in part in this paper. The El Reno group with its basal sandstone, the San Angelo, is the red clastic time equivalent of the San Andres and its basal sandstone, the Glorieta. By subsurface correlations the Whitehorse group is traced to its surface outcrop, west of Carlsbad, and is tied into Lang's Chalk Bluff formation. To the south it is traced to the Glass Mountains, where it appears to be equivalent to the Gilliam formation. Sediments of volcanic origin are present in the Leonard, San Andres and their time equivalents, gradually disappearing to the north. They are also present in the Whitehorse in its southern development.

Unconformities are recognized as the best time markers because of the changing facies. By this means the base of the Permian is found near the middle of the Cisco, as described by Plummer and Moore, and at the base of the Wolfcamp and Abo. The unconformity at the base of the Leonard of the Glass Mountains is represented on the east rim of the basin by a change in sedimentation. A conglomerate, 300 feet below the base of the Word, appears to be equivalent to the base of the El Reno group, the San Andres and the Delaware Mountain formation. An unconformity exists at the base of the Whitehorse along the entire length of the east rim of the basin. In the Glass Mountains it appears to be represented by a hiatus at the base of the Gilliam. Eleven hundred feet below the top of the Delaware Mountain formation a break in deposition has been reported which may represent this unconformity. While the lower Castile was being deposited in the southwestern portion of the basin, a hiatus occurred in the remaining areas. An unconformity at the base of the upper Castile and the Quartermaster is indicated in several areas on the east rim of the basin by a conglomerate at the base of the latter.

19. W. D. ANDERSON and JAMES R. DAY, geologists, Amerada Petroleum Corporation, Midland: Monument Field, Lea County, New Mexico.

The Monument field is in east-central Lea County, southeastern New Mexico, and at the present time represents the northernmost producing area of the Hendrick-Jal-Cooper-Eunice trend of Winkler County, Texas, and Lea County, New Mexico. Regionally, the structure is closely related to this same trend, but is locally developed as a broad anticlinal fold in contrast to the rather narrow anticlinal ridges to the south. Production is from porous dolomitic limestone of Middle Permian age and is found at an average depth of 3,950 feet. A horizontal oil zone common to the field and approximately 150 feet in thickness is found between the subsea depths of minus 200 and a common water table of minus 350. Since the oil zone is horizontal and there is considerable structural relief, production is found through a stratigraphic range of several hundred feet. A definite relationship exists between structural position and productivity. Productive limits are defined off structure by the absence of porosity above the water table. Folding occurred at intervals during Middle and Upper Permian time, but the major movement was post-Rustler in age. Prior to July 1, 1938, a total of 473 wells, each on a 40-acre unit, had been drilled, and since the field was discovered early in 1935 it had produced under proration approximately 19,750,000 barrels of oil.

20. SAM C. GIESEY and FRANK F. FULK, geologists, Stanolind Oil and Gas Company, Midland: North Cowden Field, Ector County, Texas.

Geographically, the North Cowden field is on the transition between the Llano Estacado on the north and the Edwards Plateau on the south. Geologically, it is on the eastern margin of the Central Basin platform. The presence of a structure was indicated by subsurface data, and the discovery well was completed by the Southern Crude Oil Purchasing Company in September, 1930. The producing structure is an anticline 7½ miles long, with about 100 feet of closure indicated by present control. Oil is obtained from sands and limestone of lower Whitehorse age, and production is most prolific on the east, or basinward, flank of the structure—a condition due, at least in part, to the thickening of sands basinward from the crest. The first pay is reached at an average depth of 4,027 feet, and the average amount of pay section penetrated is 89 feet. A gas cap exists in the first pay zone on the higher parts of the structure. Progressive folding during Whitehorse and upper Castile time moved the axis of the structure basinward. Post-Rustler movement shifted it about 1¼ miles west to its present position. The present productive area of the field includes 9,760 acres.

The Cowden anhydrite is defined in this paper.

21. MORRIS A. ELMS, geologist, Phillips Drilling Company, San Antonio, Texas: Volcanics of the Buck Hill Quadrangle, Brewster County, Texas.

The volcanic rocks in the north and west parts of the Buck Hill Quadrangle are a southeastern extension of the Davis Mountains of trans-Pecos Texas. Field evidence suggests a division of the volcanics of this area into two regions: (1) west of Calamity Creek the volcanic series, consisting of flows of trachyte prophyry, andesite porphyry, basalt (five flows), and rhyolite porphyry separated by beds of ash, tuff, and breccia, has a combined thickness of 2,100 feet; (2) east of Calamity Creek the rock series is distinctly different: here porphyritic olivine-free diabasic basalt flows (?) and intervening beds of ash and fresh-water conglomerates predominate and are 552 feet thick.

A major stratigraphic break separates the volcanic rocks from the underlying Upper Cretaceous rocks, and everywhere a basal conglomerate marks this unconformity. No difference in the dips of the underlying Cretaceous rocks and the volcanics is noticeable in the field, therefore the break at the base of the volcanics is considered one of disconformity rather than of angular unconformity. The age of these volcanic rocks is not known, but from available data it seems probable that they are of Cenozoic age.

SOUTH TEXAS SECTION TENTH ANNUAL MEETING CORPUS CHRISTI, OCTOBER 21–22, 1938[1]

C. C. MILLER[2]
Corpus Christi, Texas

The tenth annual meeting of the South Texas Section of the Association was held at the Plaza Hotel, Corpus Christi, Texas, October 21 and 22.

[1] Manuscript received, November 11, 1938.

[2] The Texas Company.

W. A. Maley, president of the Section, opened the meeting Friday morning on the Plaza Deck. On account of illness Donald C. Barton, president of the Association, was unable to be present and make the opening address as scheduled. A program of technical papers dealing with the geology of the South Texas Gulf Coast and adjacent provinces was presented during the morning and afternoon sessions. An attendance of about 250 geologists and guests reflected the interest shown in the papers and the resulting discussions. The eight papers on the program were arranged by Frith C. Owens, chairman of the program committee.

1. W. ARMSTRONG PRICE, consulting geologist, Corpus Christi: Correlation of the Mississippi River Terraces with the Gulf Coast Shore Lines.

2. VAUGHN C. MALEY, Humble Oil and Refining Company, Midland: Late Cretaceous and Tertiary Volcanism in Southwestern Trans-Pecos Texas.

3. ALEXANDER DEUSSEN and KENNETH DALE OWEN, Houston: Correlation of Subsurface and Surface Formations in Two Type Sections of the Texas Gulf Coast.

4. HERSCHEL H. COOPER, Cooper-Frates, Inc., San Antonio: Producing Zones in South Texas in the Jackson and Older Formations.

5. JOHN M. CLAYTON, Humble Oil and Refining Company, Corpus Christi: Producing Zones in South Texas in the Vicksburg and Younger Formations.

6. JOHN C. POOLE, Barnsdall Oil Company, Corpus Christi: Saxet Oil Field, Nueces County, Texas.

7. STUART MOSSOM, Magnolia Petroleum Company, San Antonio: General Developments in South Texas During the First Nine Months of 1938.

8. Motion Picture, by courtesy Lane Wells Company: Surveying, Perforating and Directional Drilling.

The field trip on Saturday did not conform to the plan of previous annual field trips of the Society. With a few minor exceptions the oil-producing horizors of the South Texas Gulf Coast do not crop out and therefore can not be studied on the surface. In order to compensate for this apparent handicap a trip through some of the typical oil fields of the Corpus Christi district was substituted. Three large gasoline plants processing a total of 150 million cubic feet of gas daily were visited and the operation of these plants explained by supervising engineers. P. A. Meyers, chairman of the field trip committee, assisted by W. K. Esgen, chairman of the transportation committee, directed the party of 120 geologists who made the trip. A feature of the trip was the barbecue given at noon in Welder Park near Sinton.

Social events included a tea for the ladies at the House of Gifts on Friday afternoon arranged by Mrs. Carl Beilharz, Mrs. Guy Gierhart, and Mrs. P. A. Meyers. On Saturday afternoon many of the ladies attended a cocktail party given by the Plaza Hotel in the Petroleum Club Room.

A buffet supper and dance, Saturday night on the Plaza Hotel Deck, concluded the meeting. The entertainment committee was headed by Carl Beilharz, chairman.

Officers of the South Texas Geological Society are: president, W. A. Maley; vice-president, W. W. McDonald; secretary-treasurer, C. C. Miller; members of the executive committee, Harry H. Nowlan and D. G. Barnett.

PACIFIC SECTION FIFTEENTH ANNUAL MEETING LOS ANGELES, NOVEMBER 3–4, 1938. ABSTRACTS

ROY M. BARNES
Los Angeles, California

The fifteenth annual meeting of the Pacific Section of the Association was held at the Biltmore Hotel, Los Angeles, November 3 and 4. Max L. Krueger was chairman of the program committee and H. D. Hobson was chairman of the arrangements committee.

On Thursday evening the Section had dinner at the Clark Hotel and met with the Pacific Section of the Society of Economic Paleontologists and Mineralogists, when Stanley G. Wissler presented a paper, "Notes on the Stratigraphy of Some Los Angeles Basin Oil Fields." The new officers of the S.E.P.M. Section are Wilbur D. Rankin, chairman, and Miss Lois T. Martin, secretary-treasurer, succeeding R. B. Hutcheson, chairman, and Louis J. Simon, secretary-treasurer.

On Friday night the annual dinner dance was held at the Biltmore Hotel Rendezvous. The Association Section elected Roy M. Barnes, of the Continental Oil Company, as president for the new year, and H. D. Hobson, of the Continental, as secretary-treasurer. The outgoing officers are W. S. W. Kew, president, and E. W. Galliher, secretary-treasurer.

The technical program follows.

1. OLAF P. JENKINS, State Division of Mines, San Francisco: Progress of the Geologic Branch of the State Division of Mines (abstract).

Two Bulletins, No. 115, "Bibliography, 1931–36," and No. 113, "Minerals of California," several important articles in the quarterly *Journal*, and a large colored geologic map of California—all of which should be of interest to petroleum geologists—have recently been published by the California State Division of Mines through the efforts of its Geologic Branch. In addition to assembling material for the preparation of various state mineral maps and the editing of several geologic contributions submitted for publication, the Geologic Branch has made steady progress in compiling data for the new Bulletin, "Geologic Formations and Economic Development of the California Oil and Gas Fields," as well as in editing articles prepared and contributed especially for the book by various generous authorites. A state map to accompany this Bulletin, a cross-indexed bibliography, and a glossary of names of drilled areas, are nearly complete and ready for inspection. The enterprise has met with wholehearted support. At least one-third of the papers promised have now been prepared.

2. DONALD C. BARTON, geologist, Humble Oil and Refining Company, Houston: Correlations of Crude Oils (abstract).

Useful but not perfect information in regard to the genetic relations and the lack of genetic relationship between crude oils is given by the graph of the deviation-from-normal of the interval between the A.P.I. gravity of the successive cuts of a Hempel analysis. The graph tends to be usably invariant among different samples from a common reservoir and to be usably invariant in the face of drastic oxidation and in the face of drastic weathering. Within certain limitations, crude oils which are of a common stratigraphic age and which occur in the same petroleum province may have recognizably similar

patterns in their respective graphs, whereas crude oils of different stratigraphic ages commonly have recognizably different patterns. The Permian crude oils of the West Texas basin tend to have a common pattern which, however, differs drastically from the pattern of the Sand Hills Ordovician and from the pattern of the crude from the deeper horizon at Chalk. The Cretaceous crude oils of the Powell district, Texas, show clear correlation in pattern with Cretaceous crude oils of North Louisiana and Arkansas. In the Powell district of Texas, the Corsicana 800-foot crude, the Corsicana 1,250-foot crude and the Powell 1,500-foot crude, the Woodbine crudes (all upper Upper Cretaceous) and the Kosse crude (Lower Cretaceous) have strikingly different patterns and seem not to have been derived one from the other. The serpentine plug crudes tend to have a common pattern. Three different patterns occur among the Woodbine crudes: (1) East Texas, (2) Van and Powell, and (3) Richland, Currie, and Mexia. The pattern of the last three crudes shows similarities to the common "serpentine-plug" pattern; and the Van-Powell pattern has close similarities to Nacatoch patterns of North Louisiana and Arkansas. The gravity interval therefore seems to have considerable possibilities in the study of the genetic relationships of crude oils.

3. Informal Symposium on Recent Petroleum Discoveries in California (abstract).

These are extemporaneous papers on areas of current interest and they are not intended for final publication at this time. Discussion is invited but consideration should be given to the fact that insufficient information is available on many of these for final conclusions to be reached.

(1) RICHARD W. SHERMAN, consulting geologist, Los Angeles: Newhall-Potrero Oil Field.

(2) E. B. NOBLE, chief geologist, Union Oil Company, Los Angeles: Rio Bravo Oil Field.

(3) JAN LAW, assistant petroleum engineer, Union Oil Company: A Possible Structural Interpretation of the Area of New Development at Rosecrans.

(4) ROBIN WILLIS, geologist, Basin Oil Company: (a) Northwestern Extension of the Long Beach Oil Field. (b) New Development at the Potrero Oil Field.

(5) F. M. ZIEGLER, petroleum engineer, Kern Oil Company: West Montebello Oil Field.

(6) E. J. BARTOSH, geologist, Bankline Oil Company: Eastern Extension of the Wilmington Oil Field.

(7) L. S. CHAMBERS: East Side Coalinga Extension.

(8) CLAYTON STEVENS and T. K. BOWLES, Ohio Oil Company, Bakersfield: Canal Oil Field.

(9) RICHARD G. REESE, Standard Oil Company of California, Los Angeles: New Development in the Southeastern Extension of the Torrance Oil Field.

4. HOWARD C. PYLE, Union Oil Company of California, Los Angeles: Core Analysis.

5. H. D. HOBSON, Continental Oil Company: The Nature and Extent of Movement along the San Cayetano Fault, Ventura County, California (abstract).

Data from wells recently drilled near the town of Fillmore, Ventura County, California, have shown the flat hade of the San Cayetano fault to persist laterally for a surprisingly long distance.

6. C. E. LEACH and J. C. MAY, Associated Oil Company: Notes on the Santa Susana Thrust Fault, Los Angeles County, California (abstract).

The Santa Susana thrust fault is located on the north front of the San Fernando Valley. A recent well has given data on the nature of this major structural feature.

7. HUBERT G. SCHENCK, Stanford University: Stratigraphy of Northern Iran (abstract). Presented by permission of the president, Seaboard Oil Company.

This report describes a generalized geological column for part of the Amiranian Oil Company concession in northeastern Iran, north of the main road from Teheran to Meched. The column, which is based chiefly on reconnaissance investigations by F. Reeves and B. F. Buie, shows a thickness of 30,000 ± feet of Mesozoic and Cenozoic sedimentary formations and 7,000 ± feet of Paleozoic strata. The formations of widest areal extent are Liassic, Upper Jurassic, Cretaceous, Eocene, and Miocene in age. One of the best control sections for the Cretaceous and adjacent formations is northeast of Meched, where the Cretaceous totals 9,000 ± feet. A marine Middle Eocene (Lutetian) formation, totaling 575 feet thick, rests unconformably on "red beds" of probable Danian age. Upper Senonian rudists and other megafossils occur in a 600-foot member immediately below these "red beds." At the base of the Cretaceous section is the "Red Grit Series," which is unconformably underlain by limestone containing Tithonian fossils. *Orbitolina* is present in oölitic limestones of Aptian age in the lower part of the Cretaceous sequence at many localities. No strictly marine fossils were collected from formations younger than Eocene.

8. FRANCIS P. SHEPARD, Scripps Institution of Oceanography, La Jolla: Structural Trends off the California Coast (abstract).

The sea bottom off the California coast shows a series of steep escarpments with a dominant trend in a north-northwesterly direction. The continental slope escarpment follows this direction and is not influenced by the large change in trend found on shore at Point Conception. Many of the submarine escarpments show offsets with the northerly portions set to the northeast. Also a number of the escarpments show slope reversals along their length. Directly outside the continental slope there are a series of oval mountains with trends in a north-northeasterly direction. These are probably volcanoes and from their trends suggest possible tensional phenomena.

9. JOHN H. MAXSON, California Institute of Technology, Pasadena: Miocene-Pliocene Boundary (abstract).

Geologic time is one of the great definite quantities of natural science. The measurement and subdivision of that quantity, however, introduces human error. Even in the type Tertiary section of Europe the absolute time span represented in a single epoch is difficult to establish. On the Pacific Coast further difficulties are introduced by errors in correlation by means of vertebrate, invertebrate, and micro fossils and by orogenies. Formations lying near

epoch boundaries are necessarily more ambiguous stratigraphically than others.

In California where marine and non-marine formations are intercalated, discrepancy in correlation has sometimes appeared, the vertebrate determination being higher than the invertebrate. The divergence is accentuated in the middle Tertiary by some vertebrate paleontologists who arbitrarily state that the appearance of the horse genus *Hipparion* introduced the Pliocene. Application of this criterion would place the Puente, Mint Canyon, and Modelo in the Pliocene. The writer adheres to his correlation table published in 1930 (*Carnegie Inst. Washington Pub. 404*, p. 85) placing these formations in the Upper Miocene not only on the basis of invertebrate stratigraphy but also because of morphologic and time relationships of *Hipparion* in Europe, Asia, and North America.

10. OLAF P. JENKINS, State Division of Mines, San Francisco: Geomorphic Provinces of California as Outlined on the New State Geologic Map (abstract).

Major geomorphic provinces of California: (1) Great Valley of California, (2) Sierra Nevada, (3) Cascade Range, (4) Modoc Plateau, (5) Klamath Mountains, (6) Coast Ranges, (7) Transverse Ranges, (8) Peninsular Ranges (including Los Angeles Basin), (9) Colorado Desert, (10) Mojave Desert, and (11) Basin Ranges.

11. MASON L. HILL and M. L. NATLAND, Richfield Oil Corporation: An Exposure of the Red Mountain Fault, Ventura County (abstract).

One and a half to six inches of gouge sharply separates Pliocene formations which are 11,300 feet apart in a normal stratigraphic section.

12. ROBERT S. DIETZ and K. O. EMERY: Phosphorite on the Sea Floor Off Southern California (abstract).

Dredging operations on the Scripps Institution vessel during the past year have shown that phosphorite is extensively developed on the sea floor off Southern California. This deposit is found as large nodules or as a coating on other rocks. It is particularly abundant on the numerous banks that lie off this coast and is found also on most of the submarine slopes and on the sides of a few submarine canyons. These environments are characterized by general absence of recent sediments. Some glauconitic and foraminiferal sands are associated. The phosphorite is thought to be of recent origin and the deposition is probably continuing at the present time.

13. R. A. STIRTON, introduced by B. L. Clark, University of California, Berkeley: Significance of Tertiary Mammalian Faunas in Holarctic Correlation (abstract).

The epochs of a period in the Tertiary time scale are, supposedly, convenient terms of expression, and as such, have been altered somewhat from the original designations of Lyell by different authors. Many controversies have arisen in the arbitrary assignment of boundaries to these divisions. This article is concerned with Mio-Pliocene boundary, particularly in California.

From a study of certain living mammals, it is recognized that similar fossil forms realized a wide and rapid dispersal without appreciable evolutionary change and are useful in Holarctic correlation. Furthermore, the evidence shows that different plant associations were not effective barriers to

these mammals. Hence it is again suggested that the equid genus *Hipparion* be accepted as an indicator of the beginning of the Pliocene.

The late Tertiary time scale now in use on the Pacific Coast is based, primarily, on the early identifications of fossil vertebrates from the Coalinga area in California, and in part on the percentage methods as applied to the invertebrates. The horse teeth, *Neohipparion mollе* Merriam, from the Jacalitos, which were used to mark the beginning of Pliocene time on the Pacific Coast, we now find to be very close in structural characters to Middle Pliocene forms elsewhere in America. From the evidence now available and in accordance with the above principles in intercontinental correlation, it is suggested that Pliocene time in California began with the Orinda, lower Chanac, upper Nerola and their equivalents.

MEMBERSHIP APPLICATIONS APPROVED FOR PUBLICATION

(Continued from page 1700)

FOR ASSOCIATE MEMBERSHIP

C. Harold Acheson, Houston, Tex.
L. W. Blau, J. E. LaRue, Dave P. Carlton

James William Bowler, Cucuta, Colombia, S. A.
Carl W. Hubman, C. W. Flagler, Frank B. Notestein

Jack W. Davies, Wichita, Kan.
James I. Daniels, Glen C. Woolley, Edward A. Koester

Max D. Engle, Mattoon, Ill.
T. C. Hiestand, Clare M. Clark, Gerald C. Maddox

Arthur E. Feldmeyer, Bakersfield, Calif.
E. C. Simpson, H. Allen Kelley, D. E. Taylor

Hiram Darby Hand, Laramie, Wyo.
R. G. Greene, Horace D. Thomas, R. H. Beckwith

Bernard Christian Refshauge, Maracaibo, Venezuela, S. A.
J. L. Kalb, M. B. Arick, John G. Douglas

Joseph John Uri, Alice, Tex.
Sidney A. Packard, Worth W. McDonald, Richard T. Short

FOR TRANSFER TO ACTIVE MEMBERSHIP

Robert M. Franks, Alice, Tex.
Ed. W. Owen, W. Grant Blanchard, George D. Stevens

Clifton W. Johnson, Los Angeles, Calif.
W. S. W. Kew, James C. Kimble, Rollin Eckis

Albert Douglas Miller, Lafayette, La.
Alfred Gray, A. F. Crider, Niles B. Winter

Edward H. Ogier, Ventura, Calif.
A. A. Curtice, H. J. Steiny, E. J. Bartosh

William B. Sinclair, Tulsa, Okla.
A. R. Denison, Dollie Radler Hall, Rex McGehee

George Rutherford Wesley, Owensboro, Ky.
Daniel J. Jones, Hugh D. Miser, N. W. Shiarella

Hans Winkler, Austin, Tex.
F. H. Lahee, D. M. Collingwood, E. H. Sellards

ASSOCIATION COMMITTEES

EXECUTIVE COMMITTEE

DONALD C. BARTON, *chairman*, Houston, Texas — H. B. FUQUA, Fort Worth, Texas
IRA H. CRAM, *secretary*, Tulsa, Oklahoma — HAROLD W. HOOTS, Los Angeles, California
W. A. VER WIEBE, Wichita, Kansas

BUSINESS COMMITTEE

CARL C. ANDERSON (1940)
ARTHUR A. BAKER (1940)
DONALD C. BARTON (1940)
WILLIAM A. BAKER (1939)
ORVAL L. BRACE (1939)
CARY P. BUTCHER (1939)
FREDERIC A. BUSH (1939)
HAROLD S. CAVE (1939)
IRA H. CRAM (1939)
A. F. CRIDER (1939)
A. ARTHUR CURTICE (1939)
H. B. FUQUA (1939)
BENJAMIN F. HAKE (1939)
V. G. HILL (1939)
HAROLD W. HOOTS (1939)
H. V. HOWE (1939)
J. HARLAN JOHNSON (1939)
EDWARD A. KOESTER (1939)
P. W. MCFARLAND (1940)
DAVID PERRY OLCOTT (1939)
VIRGIL PETTIGREW (1940)
PAUL H. PRICE (1939)
R. B. RUTLEDGE (1939)
R. F. SCHOOLFIELD (1939)
E. H. SELLARDS (1939)
FRED P. SHAVES (1939)
S. E. SLIPPER (1939)
HOMER J. STEINY (1939)
W. T. THOM, JR. (1939)
WALLACE C. THOMPSON (1940)
JAMES A. TONG (1939)
WALTER A. VER WIEBE (1939)
ANDREW C. WRIGHT (1939)
CHARLES E. YAGER (1939)

RESEARCH COMMITTEE

A. I. LEVORSEN (1941), *chairman*, 221 Woodward Boulevard, Tulsa, Oklahoma
HAROLD W. HOOTS (1939), *vice-chairman*, Richfield Oil Corporation, Los Angeles, California
M. G. CHENEY (1941), *vice-chairman*, Coleman, Texas

DONALD C. BARTON (1939)
GLENN H. BOWES (1939)
W. L. GOLDSTON (1939)
W. C. SPOONER (1939)
PARKER D TRASK (1939)
MAURICE M. ALBERTSON (1940)
ROLLIN ECKIS (1940)
WILLIAM E. HUBBARD (1940)
JOHN C. KARCHER (1940)
NORMAN L. THOMAS (1940)
N. W. BASS (1941)
E. WAYNE GALLIHER (1941)
H. HLAUSCHEK (1941)
WALTER KAUENHOWEN (1941)
BEN H. PARKER (1941)
WENDELL P. RAND (1941)

REPRESENTATIVE ON DIVISION OF GEOLOGY AND GEOGRAPHY NATIONAL RESEARCH COUNCIL

FREDERIC H. LAHEE (1940)

GEOLOGIC NAMES AND CORRELATIONS COMMITTEE

JOHN G. BARTRAM, *chairman*, Standard Oil and Gas Company, Casper, Wyoming
GLENN S. DILLE, *vice-chairman*, 808 Atlas Building, Tulsa, Oklahoma

J. E. ADAMS
M. G. CHENEY
ALEXANDER DEUSSEN
ROBERT H. DOTT
ANTHONY FOLGER
B. F. HAKE
G. D. HANNA
M. C. ISRAELSKY
R. M. KLEINPELL
C. L. MOODY
R. C. MOORE
ED. W. OWEN
PAUL H. PRICE
R. E. SHERRILL
N. L. THOMAS

TRUSTEES OF REVOLVING PUBLICATION FUND

J. V. HOWELL (1939) — RALPH D. REED (1940) — BEN F. HAKE (1941)

TRUSTEES OF RESEARCH FUND

ALEX W. MCCOY (1939) — ROBERT J. RIGGS (1940) — A. A. BAKER (1941)

FINANCE COMMITTEE

W. B. HEROY (1939) — E. DEGOLYER (1940) — WALLACE E. PRATT (1941)

COMMITTEE ON APPLICATIONS OF GEOLOGY

FRANK RINKER CLARK, *chairman*, Box 981, Tulsa, Oklahoma

OLIN G. BELL
ARTHUR E. BRAINERD
IRA OTHO BROWN
HAL P. BYBEE
CAREY CRONEIS
ROBERT H. DOTT
CHALMER J. ROY
H. S. MCQUEEN
C. R. MCKNIGHT
S. E. SLIPPER
E. K. SOPER
EARL A. TRAGER

COMMITTEE FOR PUBLICATION

FREDERIC H. LAHEE, *chairman*, Box 2880, Dallas, Texas

CARL C. ANDERSON
WALTER R. BERGER
CHARLES BREWER, JR.
T. C. CRAIG
GEORGE R. DOWNS
JAMES TERRY DUCE
JAMES FITZGERALD, JR.
HAROLD W. HOOTS
J. HARLAN JOHNSON
EDWARD A. KOESTER
CHAS. H. LAVINGTON
A. I. LEVORSEN
A. M. LLOYD
W. A. MALEY
PHILLIP F. MARTYN
JOSEPH J. MAUCINI
GRAHAM B. MOODY
ED. W. OWEN
R. E. RETTGER
J. T. RICHARDS
THERON WASSON
A. C. WRIGHT

BULLETIN OF THE AMERICAN ASSOCIATION OF PETROLEUM GEOLOGISTS
VOL. 22, NO. 12 (DECEMBER, 1938), PP. 1720-1722

AT HOME AND ABROAD

CURRENT NEWS AND PERSONAL ITEMS OF THE PROFESSION

NOEL EVANS, Tide Water Associated Oil Company, has changed his address from Houston, Texas, to Owensboro, Kentucky.

S. K. VAN STEENBERGH, Texas Company, formerly of Venice, Louisiana, may now be addressed at Box 2332, Houston, Texas.

ELMER M. RICE presented his ideas in regard to the problem of "Correlation of the Woodbine Formation in the East Texas Basin," before the East Texas Geological Society on October 24, at Tyler.

J. T. STILL, of Houston, Texas, has been doing geological work in Greece for several months.

Mrs. KENNETH A. JOHNSTON, who has been librarian and technical assistant in the exploration department of the Union Oil Company at Los Angeles, has resigned that position and joined Mr. JOHNSTON, who is resident geologist for the Buttes Oilfields, Inc., at Marysville, California, where that company is developing a new gas field.

The Penrose Medal, highest honor of the Geological Society of America, has been awarded to ANDREW COWPER LAWSON, professor emeritus of geology and mineralogy at the University of California, and honorary member of the American Association of Petroleum Geologists, "for eminent research in pure geology, and outstanding original contributions and achievements which mark a decided advance in the science of geology."

THOMAS W. LEACH, who has been doing geological work in North Dakota in connection with The California Company, has returned to his home in Tulsa, Oklahoma.

C. P. PARSONS, Halliburton Oil Well Cementing Company, spoke before the Houston Geological Society, November 3, on "Squeezing Cement into Permeable Formations."

CECIL L. CHATMAN, geologist for the Humble Oil and Refining Company at Wink, Texas, died at the home of his parents at Shawnee, Oklahoma, on October 25.

HARVEY WHITAKER, Bridwell Oil Company, has been transferred from San Antonio to Mattoon, Illinois.

MELVIN M. GARRETT, consulting geologist of Dallas, Texas, spoke before a meeting of the Dallas Petroleum Geologists on November 1. He reviewed the history of Strawn development in west-central and north Texas.

CHARLES W. LANE, formerly with the Indian Territory Illuminating Oil Company at Wichita, Kansas, has joined the geological staff of the Pure Oil Company at Tulsa, Oklahoma.

The Houston Geological Society holds regular meetings every Thursday at 12 o'clock noon above Kelly's Restaurant at 910 Texas Avenue. Secretary CARLETON D. SPEED, JR., 1315 Second National Bank Building, will be glad to furnish particulars about these meetings.

The Pacific Section of the Association at Los Angeles, California, has elected the following officers: president, ROY E. BARNES, Continental Oil Company; secretary-treasurer, H. D. HOBSON, Continental Oil Company. The outgoing officers are W. S. W. KEW, president, and E. W. GALLIHER, secretary-treasurer.

The semi-centennial meeting of the Geological Society of America will be held at the Waldorf Astoria Hotel, New York City, on December 28–30, 1938.

The American Association for the Advancement of Science will hold its annual meeting at Richmond, Virginia, December 27–31. Section E, Geology and Geography, meets on December 27–29, and will be devoted to study of the geology of the Piedmont and the Blue Ridge, and to the historical and economic geography of Virginia and the Carolinas.

The annual meeting of the A.I.M.E. will be held in New York, February 13–16, 1939.

The Paleontological Society, the Mineralogical Society of America, the Seismological Society of America, and the Society of Economic Geologists will hold their annual meetings in conjunction with the annual meeting of the Geological Society of America, December 28–30, at the Waldorf-Astoria in New York.

JOHN E. GALLEY, Shell Petroleum Corporation, formerly district geologist at Amarillo, Texas, has been transferred to Tulsa, Oklahoma, as regional geologist.

F. A. SUTTON, formerly with the Standard Oil Company of Argentina, is now with the Standard Oil Company of Venezuela at Caracas.

HALL EDWARDS has been made a codirector of the office of the Superior Oil Company of California at Evansville, Indiana. He was formerly at Midland, Texas.

DONALD J. MACNEIL, Shell Petroleum Corporation, has been transferred from Tulsa, Oklahoma, to Wichita Falls, Texas.

FRED W. BARTLETT, division geologist for the Shell Petroleum Corporation at Houston, Texas, has resigned to enter the oil business as an independent operator in southwest Texas.

RAYMOND M. LARSEN, U. S. Geological Survey, formerly at Washington, D. C., may now be addressed at 305 Federal Building, Casper, Wyoming.

CHESTER A. BAIRD, formerly assistant chief geologist for the Mene Grande Oil Company in Venezuela, is now in charge of the exploratory and preliminary work for the Gulf Oil Corporation in Denmark, and may be addressed at Gammeltorv, 6, Copenhagen.

JOHN L. P. CAMPBELL may be addressed in care of the Seaboard Oil Company, Box 241, Mattoon, Illinois.

W. C. RAUCH, Union Oil Company of California, has been transferred from Roosevelt, Utah, to Santa Maria, California.

PARKER A. ROBERTSON, formerly of London, England, has changed his address to Box 778, Tyler, Texas.

R. G. SOHLBERG, formerly of Medicine Hat, Alberta, may now be addressed in care of The California Company, Denver, Colorado.

HERSCHEL H. COOPER, San Antonio, Texas, spoke before the Houston Geological Society, November 17 on "Producing Zones in South Texas in the Jackson and Older Formations."

WILLIAM L. RUSSELL, recently located at Owensboro, Kentucky, has accepted a geological assignment to South Africa. He may be addressed at Box 35, Cape Town, Union of South Africa.

MARGARET STEARNS BISHOP and BARTON PHELPS BISHOP have opened Geological and Geophysical Consulting offices at Paw Paw, Michigan.

G. H. CROWL, of Wooster, Ohio, who was recently working for the United States Geological Survey in California, is now on the geological staff of the Shell Petroleum Corporation, Tulsa, Oklahoma.

FREDERICK G. CLAPP, who has recently returned to the United States after nearly 3 years of almost continuous absence in Iran and Afghanistan, spoke before the Iran Society and the Royal Central Asian Society at Burlington House, London, October 28. His subject was "Recent Explorations in Eastern Iran."

HENRY CARTER REA, district geologist for the Shell Petroleum Corporation in Kentucky, sailed aboard the Bremen, November 16, from New York for Europe.

"Core Analysis and Interpretation" is the subject of an article by HOWARD C. PYLE and JOHN E. SHERBORNE, Union Oil Company of California, which Pyle presented before a joint meeting of the Tulsa Geological Society and the Mid-Continent section of the American Institute of Mining and Metallurgical Engineers at Tulsa on November 21.

The third annual meeting of the Carolina Geological Society was held on November 12 and 13 with 35 members and 26 visitors in attendance. The meeting was held at the University of South Carolina, Columbia, South Carolina. Field trips were arranged and directed by professors Taber, Smith, and Petty, of the University of South Carolina. The following officers were elected for the coming year. President, L. L. SMITH, University of South Carolina, Columbia, South Carolina; vice-president, J. H. WATKINS, The Citadel, Charleston, South Carolina; secretary-treasurer, WILLARD BERRY, Duke University, Durham, North Carolina.

LINCOLN R. PAGE, University of Colorado, Boulder, spoke before the Rocky Mountain Association of Petroleum Geologists at Denver, Colorado, November 21, on "New Hampshire Geology."

BULLETIN OF THE AMERICAN ASSOCIATION OF PETROLEUM GEOLOGISTS
VOL. 22, NO. 12 (DECEMBER, 1938), PP. 1723-1746

INDEX OF VOLUME 22

Abstracts, Mid-Year Meeting, El Paso, September 27–October 2, 1938 . . 1702
———, Pacific Section Fifteenth Annual Meeting, Los Angeles, November 3–4, 1938 . . . . . .
———, Second Venezuelan Geological Congress 1714
Acadia Parish, Louisiana, Geology of Tepetate Oil Field. By Max Bornhauser and Fred W. Bates 285
Accumulation, Criteria for Determining the Time of, Under Special Circumstances. By Stanley C. Herold 834
Active Faulting in Lavaca County, Texas. Geological Note by Douglas E. Bell and V. A. Brill 104
Activities in South Texas, 1937–1938. By Stuart Mossom 750
Adams, John Emery, and Page, Lincoln R. Stratigraphy, Eastern Midland Basin, Texas. Abstract 1709
Additional Membership Applications Approved for Publication, March, 1938 . 391
Aerial Geologist, Guadalupe Mountains as They Look to the. By Cary P. Butcher. Abstract 1706
Aerial Photography for Geological Exploration. By Louis V. Olson. Abstract . 1706
Aguerrevere, S. E., and Lopez, V. M. The Geology of the Island Gran Roque and Its Phosphatic Deposits. Abstract 1105
Alabama, Mississippi, and Florida, Subsurface Tertiary Zones of Correlation through. By Donald W. Gravell and Marcus A. Hanna 984
Alabama, Western, and Mississippi, Eastern, Correlation of Cockfield and Gosport Formations. Geological Note by B. W. Blanpied and Roy T. Hazzard . 309
Alabama and Mississippi, Stratigraphy of Upper Cretaceous Series in. By L. W. Stephenson and W. H. Monroe 1639
Alberta, Origin of McMurray Oil Sands. By J. C. Sproule 1133
Alteration Products in Miocene Clays of Guarico. By G. D. Johnson. Abstract . 1105
America, North, Comparison of Permian Ammonoid Zones of Soviet Russia with Those of. By A. K. Miller 1014
American Association of Petroleum Geologists, Constitution and By-Laws . . 618
———, Financial Statement, 1937 329
———, Headquarters Office 594
———, Membership List, March 4, 1938 338
———, Mid-Year Meeting 1701
———, Twenty-Fourth Annual Meeting. Announcement . . . 1299, 1467, 1700
———, Twenty-Third Annual Meeting 117, 231, 577
American Geophysical Union, Transactions, 1937. Review by Donald C. Barton 111
A.I.M.M.E. Petroleum Division. Petroleum Development and Technology, 1938. Review by Harry H. Power 1457
Ammonoid Zones, Permian, of Soviet Russia, Comparison of with Those of North America. By A. K. Miller 1014
Anderson, W. D., and Day, James R. Monument Field, Lea County, New Mexico. Abstract 1711
Andree, K., Brouwer, H. A., and Bucher, W. H. editors. *Regional Geologie der Erde* (Regional Geology of the Earth). Review by R. D. Reed . . . 929
Angularity of Grain, Effect of, on Porosity and Permeability of Unconsolidated Sands. Geological Note by Frederick G. Tickell and William N. Hiatt . 1272
Anticlinal Theory and Later Developments in West Virginia. By Paul H. Price . 1097
Anzoategui, Geology of El Valle de Guanape Area. District of Bruzual. By K. F. Dallmus. Abstract 1104
Appalachian Fields, History of Development and Geologic Relationships. By George H. Ashley 416
Appalachian Geological Society. Oriskany Sand Symposium. Review by Elizabeth E. Stephenson 222
Appalachian Province, Regional Variations in Composition of Natural Gas in. By Paul H. Price and A. J. W. Headlee 1153
Application of Principle of Differential Settling to Tracing of Lenticular Sand Bodies. By John L. Rich 823

Applications of Geology, Report of Committee on. By Frank R. Clark . . . 611
Aragonite in Texas and Louisiana Salt-Dome Cap Rocks. Geological Note by Marcus A. Hanna and Albert G. Wolf . . . 217
Arkansas, South, and North Louisiana, Developments in, in 1937. By H. K. Shearer . . . 719
———, South, Stratigraphy with Emphasis on the Older Coastal Plain Beds. By Warren B. Weeks . . . 953
Arkansas Geological Survey, List of Arkansas Oil and Gas Wells. Review by E. R. Brockway . . . 112
Arkansas Oil and Gas Wells, List of. By Arkansas Geological Survey. Review by E. R. Brockway . . . 112
Ascension Parish, Louisiana, Darrow Salt Dome. By Carroll E. Cook . . . 1412
Ashley, George H. History of Development and Geologic Relationships of Appalachian Fields . . . 416
Aspect and Zonation of the Molluscan Fauna in the La Rosa and Lagunillas Formations, Bolivar Coastal Fields, Venezuela. By W. S. Hoffmeister. Abstract . . . 1104
Association Committees 123, 237, 328, 508, 626, 783, 945, 1126, 1301, 1468, 1619, 1719
———, Origin of . . . 1616
Association Meetings . . . 117, 231, 577, 625, 782, 943, 1122, 1297, 1299, 1467, 1701
Association Membership List . . . 338, 1293
Association Round Table, The, . . . 116, 229, 326, 507, 576, 781, 940, 1117, 1292, 1466, 1613, 1698
At Home and Abroad . . . 124, 238, 385, 513, 628, 784, 946, 1129, 1302, 1469, 1623, 1720
Atlantic Coastal Plain from New Jersey to Florida, Oil and Gas Possibilities in. By Olive C. Postley . . . 799

Ballard, Norval. Stratigraphy and Structural History of East-Central United States . . . 1519
Barinas, State of, Venezuela, Pre-Cretaceous Rocks in. By M. M. Knechtel. Abstract . . . 1105
Barilla and Eastern Davis Mountains of Trans-Pecos Texas, Cretaceous and Eocene Stratigraphy of. By C. T. Jones . . . 1423
Barnes, Roy M. Pacific Section Fifteenth Annual Meeting, Los Angeles, November 3–4, 1938. Abstracts . . . 1714
Barsch, O. *Die Geophysikalische Reichsaufnehme als Grundlage für die Erschliessung neuer Lagerstätten* (Geophysical Survey of the Reich as Background for Prospecting for Mineral Deposits). Review by Walter Kauenhowen . . . 494
Bartle, Glenn G. Subsurface Study of Cherokee Formation Near Kansas City, Missouri. Geological Note . . . 918
Barton, Donald C. Correlations of Crude Oils. Abstract . . . 1714
———. Report of Research Committee . . . 605
———. Review of Journal of Geomorphology, edited by Douglas W. Johnson . . . 502
———. Review of Practical Seismology and Seismic Prospecting, by L. Don Leet . . . 1607
———. Review of Report of the Committee on Sedimentation, 1936–1937, by National Research Council . . . 223
———. Review of Studies in Scientific Method, by Douglas W. Johnson . . . 502
———. Review of Transactions American Geophysical Union, 1937 . . . 111
———. Supplementary Report . . . 608
Bartosh, E. J. Eastern Extension of Wilmington Oil Field. Abstract . . . 1715
———. Wilmington Oil Field, Los Angeles County, California . . . 1048
Bartram, John G. Report of Committee on Geologic Names and Correlations 604
———. Use of Stratigraphic Names. Geological Note . . . 763
Bass, N. Wood. Origin of the Shoestring Sands of Greenwood and Butler Counties, Kansas. Review by J. L. Garlough . . . 1458
———. Review of Oil and Gas Resources of Western Kansas, by Walter A. Ver Wiebe . . . 1287
Bates, Fred W., and Bornhauser, Max. Geology of Tepetate Oil Field, Acadia Parish, Louisiana . . . 285
Becker, Clyde M. Memorial by L. J. Fulton . . . 1620
Behavior of Fluids in Oil Reservoirs. By T. V. Moore . . . 1237
Bell, Alfred H., and Cohee, George V. Recent Petroleum Development in Illinois 649
Bell, Douglas E., and Brill, V. A. Active Faulting in Lavaca County, Texas. Geological Note . . . 104

Bell, Olin G. Friendswood Field, Harris County, Texas. Geological Note . . 1602
Bellevue Oil Field, Bossier Parish, Louisiana, Geology of. By A. F. Crider. . 1658
Bendian of the Oklahoma Salient of the Ouachita Mountains, Stratigraphy of. By Bruce H. Harlton 852
Bentz, Ivan Vincent. Memorial by L. B. Snider 1127
Bibliography of Geologic Structure Maps and Cross Sections of Areas in Oil and Gas States East of the Mississippi River, and Some Producing States in the Mid-Continent Region. By Olive C. Postley 431
——— of West Indian Geology. By L. M. R. Rutten. Review by R. D. Reed 1460
Bighorn Basin-Yellowstone Valley Structural Field Conference, 1937. Geological Note by W. T. Thom, Jr. 306
Billingsley, J. E. Early Development of Drilling Practices in Kanawha County, West Virginia 1088
Black Shale Basin of West Texas; a Preliminary Report. By Taylor Cole. Abstract 1710
Blanpied, B. W., and Hazzard, Roy T. Correlation of Cockfield and Gosport Formations, Eastern Mississippi and Western Alabama. Geological Note 309
Bodcaw Sand, Discovery of Oil in, Cotton Valley Field, Webster Parish, Louisiana. Geological Note by A. A. Holston 1603
Bolivar, District of, State of Zulia, Venezuela, Notes on the Stratigraphy of the Younger Tertiary Formations of. By G. E. Manger. Abstract 1103
Bolivar Coastal Fields, Fresh-Water Resources of. By J. G. Douglas. Abstract 1103
———, Venezuela, Aspect and Zonation of the Molluscan Fauna in the La Rosa and Lagunillas Formations. By W. S. Hoffmeister. Abstract 1104
Borden, Joseph L. Eleventh Annual Field Conference, Kansas Geological Society, September 2–6, 1937. Geological Note 100
———. Review of Geology of Muskogee-Porum District, Muskogee and McIntosh Counties, Oklahoma, by Charles W. Wilson, Jr. 224
Bornhauser, Max, and Bates, Fred W. Geology of Tepetate Oil Field, Acadia Parish, Louisiana 285
Bossier and Webster Parishes, Louisiana, Carterville-Sarepta and Shongaloo Fields. By G. D. Thomas 1473
Bossier Parish, Louisiana. Geology of Bellevue Oil Field. By A. F. Crider . . 1658
Bowles, T. K., and Stevens, Clayton. Canal Oil Field. Abstract 1715
Boyd, W. Baxter. Jesse Pool, Pontotoc and Coal Counties, Oklahoma . . . 1560
Brace, O. L. Gulf Coastal Developments in 1937. 736
Breckinridge, Meade, and Hardin Counties, Kentucky, Chester Rocks of. By Ralph E. Stouder 267
Brill, V. A., and Bell, Douglas E. Active Faulting in Lavaca County, Texas. Geological Note 104
Brockway, E. R. Review of List of Arkansas Oil and Gas Wells, by Arkansas Geological Survey 112
Buck Hill Quadrangle, Brewster County, Texas, Volcanics of. By Morris A. Elms. Abstract 1712
Business Committee, Report of. By Ira H. Cram 602
Butcher, Cary P. The Guadalupe Mountains as They Look to the Aerial Geologist. Abstract 1706
Bybee, H. P. Possible Nature of Limestone Reservoirs in the Permian Basin. Geological Note 915
Bybee, H. P., Haigh, Berte R., and Cole, Taylor. Developments in West Texas and Southeastern New Mexico in 1937 694

California as Outlined on the New State Geologic Map, Geomorphic Provinces of. By Olaf P. Jenkins. Abstract 1714
———, Discoveries and Additions to Oil Reserves in, during 1937. By Harold W. Hoots 701
———, Nature and Extent of Movement along the San Cayetano Fault, Ventura County. By H. D. Hobson. Abstract 1716
———, Notes on the Santa Susana Thrust Fault, Los Angeles County. By C. E. Leach and J. C. May. Abstract 1716
———, Sediments of Santa Monica Bay. By F. P. Shepard and G. A. Macdonald 201
———, Southern, Phosphorite on the Sea Floor Off. By Robert S. Dietz and K. O. Emery. Abstract 1717

———, Wilmington Oil Field, Los Angeles County. By E. J. Bartosh . . . 1048
California Coast, Structural Trends off the. By Francis P. Shepard. Abstract 1716
Camp, Charles L., and Hanna, G. Dallas. Methods in Paleontology. Review by Ralph D. Reed . . . 317
Campbell, F. F. Discovery Rates in Oil Finding. Discussion . . . 109
Canal Oil Field. By Clayton Stevens and T. K. Bowles. Abstract . . . 1715
Carterville-Sarepta and Shongaloo Fields, Bossier and Webster Parishes, Louisiana. By G. D. Thomas . . . 1473
Case, L. C. Discussion of Powder Wash Field, Colorado, Water Analysis, by W. T. Nightingale . . . 1604
Castile Formation of Southeast New Mexico, Salt, Potash, and Anhydrite in the. By George A. Kroenlein. Abstract . . . 1707
Cedar Point Field, Chambers County, Texas. Geological Note by Joseph M. Wilson . . . 1601
Chambers, L. S. East Side Coalinga Extension. Abstract . . . 1715
Chapel Hill Pool, Smith County, Texas. Geological Note by F. H. Lahee . . 1107
Cheney, M. G. Geology of North-Central and Central Texas. Abstract . . 1703
Cherokee Formation Near Kansas City, Missouri, Subsurface Study of. Geological Note by Glenn G. Bartle . . . 918
Chester Rocks of Meade, Hardin, and Breckinridge Counties, Kentucky. By Ralph E. Stouder . . . 267
Chinati Mountains, Presidio County, Texas, Upper Paleozoic Section of. By John W. Skinner. Abstract . . . 1705
Chinati Series, Upper Paleozoic, Presidio County, Texas. Geological Note by John W. Skinner . . . 924
Claiborne Parish, Louisiana, Sugar Creek Field. By C. C. Clark . . . 1504
Clark, C. C. Sugar Creek Field, Claiborne Parish, Louisiana . . . 1504
Clark, Frank R. Report of Committee on Applications of Geology . . . 611
Cleaves, Arthur B. Conditions of Sedimentation and Sources of the Oriskany Sandstone as Indicated by Petrology. Discussion . . . 1108
Cleveland Field, Liberty County, and Segno Field, Polk County, Texas, Wilcox Eocene Production at. Geological Note by Marcus A. Hanna . . . 1274
Coalinga Extension, East Side. By L. S. Chambers. Abstract . . . 1715
Coastal Plain, Atlantic, from New Jersey to Florida, Oil and Gas Possibilities in. By Olive C. Postley . . . 799
——— of Georgia, Stratigraphy of. By C. Wythe Cooke and Arthur C. Munyan 789
——— of Southern Georgia, Recent Petroleum Activities in. By A. C. Munyan 794
Coastal Plain Beds, Older, South Arkansas Stratigraphy with Emphasis on. By Warren B. Weeks . . . 953
Cockfield and Gosport Formations, Eastern Mississippi and Western Alabama, Correlation of. Geological Note by B. W. Blanpied and Roy T. Hazzard . 309
Cohee, George V., and Bell, Alfred H. Recent Petroleum Development in Illinois 649
Cole, Taylor. The Black Shale Basin of West Texas; a Preliminary Report. Abstract . . . 1710
Cole, Taylor, Bybee, H. P., and Haigh, Berte R. Developments in West Texas and Southeastern New Mexico in 1937 . . . 694
Colorado, Northwest, Petroleum and Natural Gas in Non-Marine Sediments of Powder Wash Field in. By W. T. Nightingale . . . 1020, 1604
Committee on Applications of Geology, Report of. By Frank R. Clark . . . 611
——— on Geologic Names and Correlations, Report of. By John G. Bartram 604
Comparison of Permian Ammonoid Zones of Soviet Russia with Those of North America. By A. K. Miller . . . 1014
——— of Upper Cretaceous Deposits of Gulf Region and Western Interior Region. By Lloyd W. Stephenson and John B. Reeside, Jr. . . . 1629
Conditions of Sedimentation and Sources of the Oriskany Sandstone as Indicated by Petrology. By Marcellus H. Stow . . . 541
——— of Sedimentation and Sources of the Oriskany Sandstone as Indicated by Petrology, by Marcellus H. Stow. Discussion by Arthur B. Cleaves . . 1108
Constitution and By-Laws. The Association Round Table . . . 618
Contributions to the Geology of the Zulia-Falcon Basin. By C. Gonzalez de Juana. Abstract . . . 1104
Cook, Carroll E. Darrow Salt Dome, Ascension Parish, Louisiana . . . 1412
Cooke, C. Wythe, and Munyan, Arthur C. Stratigraphy of Coastal Plain of Georgia . . . 789

Cooper, Byron N. Review of Paleozoic Formations in the Light of the Pulsation Theory, Vol. III, Cambrovician Pulsation System, by Amadeus W. Grabau 934
Cores from a Deep Well at Rodessa, Caddo Parish, Louisiana. Geological Note by M. C. Israelsky 764
"Corniferous" Oil in Eastern Kentucky, Source of. Geological Note by Ralph N. Thomas 1452
Correlation of Cockfield and Gosport Formations, Eastern Mississippi and Western Alabama. Geological Note by B. W. Blanpied and Roy T. Hazzard 309
——— of the Pennsylvanian Rocks of New Mexico. By C. E. Needham. Abstract 1705
———, Subsurface Tertiary Zones of, through Mississippi, Alabama, and Florida. By Donald W. Gravell and Marcus A. Hanna 984
Correlations of Crude Oils. By Donald C. Barton. Abstract 1714
Cotton Valley Field, Webster Parish, Louisiana, Discovery of Oil in Bodcaw Sand. Geological Note by A. A. Holston 1603
Cram, Ira H. Minutes, Twenty-Third Annual Business Meeting, Roosevelt Hotel, New Orleans, Louisiana, March 16–18, 1938. The Association Round Table 590
———. Report of Secretary-Treasurer 593
Cretaceous and Eocene Stratigraphy of Barrilla and Eastern Davis Mountains of Trans-Pecos Texas. By C. T. Jones 1423
Cretaceous of Trinidad, Notes on. By A. G. Hutchison. Abstract 1105
Cretaceous Deposits, Upper, of Gulf Region and Western Interior Region, Comparison of. By Lloyd W. Stephenson and John B. Reeside, Jr. 1629
Cretaceous Formations in the Neighborhood of the Rio Carache Valley, State of Trujillo, Stratigraphy of. By W. G. C. Tomalin. Abstract 1103
Cretaceous Series, Upper, in Mississippi and Alabama, Stratigraphy of. By L. W. Stephenson and W. H. Monroe 1639
Cretaceous Strata, Upper, of Diablo Range, Source of. By Ralph D. Reed. Abstract 1715
Crider, A. F. Geology of Bellevue Oil Field, Bossier Parish, Louisiana . . . 1658
Criteria for Determining the Time of Accumulation Under Special Circumstances. By Stanley C. Herold 834
Crude Oils, Correlations of. By Donald C. Barton. Abstract 1714
Custer Formation of Texas. Discussion by Leroy T. Patton 925

Dallmus, K. F. Geology of El Valle de Guanape Area, District of Bruzual, Anzoategui. Abstract 1104
Dane, C. H. Review of the Land of Sheba, by H. St. J. B. Philby 1606
Darrow Salt Dome, Ascension Parish, Louisiana. By Carroll E. Cook . . . 1412
Darton, N. H., Honorary Member. By Hugh D. Miser. The Association Round Table 1118
Das marine Paläozän und Eozän in Norddeutschland und Südskandinavien, mit einer Zusammenstellung der gesamten Literatur (Marine Paleocene and Eocene of North Germany and South Scandinavia, with an Exhaustive Bibliography). By Theodor Müller. Review by Ralph D. Reed 315
Davis, Eastern, and Barrilla Mountains of Trans-Pecos Texas, Cretaceous and Eocene Stratigraphy of. By C. T. Jones 1423
Day, James R., and Anderson, W. D. Monument Field, Lea County, New Mexico. Abstract 1711
Decker, Charles E. Transcendent Value of Graptolites for Correlation Demonstrated. Geological Note 221
Deep Well near Marlow, Stephens County, Oklahoma. Geological Note by E. A. Paschal 1106
Deepest Rocks at Jackson, Mississippi. Discussion by Watson H. Monroe . . 927
DeFord, Ronald K. Naming Subsurface Formations. Discussion 1280
———. Surface and Subsurface Formations, Eddy County, New Mexico. Abstract 1706
Deussen, Alexander. Report of Resolutions Committee 616
Deutschen Alpen und ihre Enstehung, die (The German Alps and Their Origin). By Max Richter. Review by R. D. Reed 1112
Development and Geologic Relationships of Appalachian Fields, History of. By George H. Ashley 416
Developments, Gulf Coastal, in 1937. By O. L. Brace 736

———, in Kansas in 1937. By Rycroft G. Moss 666
———, in Michigan Basin, Recent. By E. A. Newman 659
———, in Rocky Mountain Region in 1937. By E. H. Hunt. 677
———, in South Arkansas and North Louisiana in 1937. By H. K. Shearer . 719
———, in West Texas and Southeastern New Mexico in 1937. By H. P. Bybee, Berte R. Haigh, and Taylor Cole 694
———, Later, and Anticlinal Theory in West Virginia. By Paul H. Price . . 1097
Diablo Range, Source of Upper Cretaceous Strata of. By Ralph D. Reed. Abstract 1715
Dickey, Robert I. Geologic Cross Section from Fisher County through Andrews County, Texas, to Eddy County, New Mexico. Abstract 1702
Dietz, Robert S. and Emery, K. O. Phosphorite on the Sea Floor Off Southern California. Abstract 1717
Differential Settling, Application of Principle of, to Tracing of Lenticular Sand Bodies. By John L. Rich 823
Discoveries and Additions to Oil Reserves in California during 1937. By Harold W. Hoots 701
Discovery of Oil in Bodcaw Sand, Cotton Valley Field, Webster Parish, Louisiana. Geological Note by A. A. Holston 1603
Discovery Rates in Oil Finding. Discussion by F. F. Campbell 109
Discussion 109, 771, 925, 1108, 1280, 1604
Douglas, J. G. Fresh-Water Resources of the Bolivar Coastal Fields. Abstract 1103
Drilling, Economic Aspects of. By Joseph E. Pogue 633
———, Wildcat, in 1937. By Frederic H. Lahee 645
Drilling Practices in Kanawha County, West Virginia, Early Development of. By J. E. Billingsley 1088
Dry Creek and Golden Structures, Carbon County, Montana, Revision of Stratigraphy of. Geological Note by Charles W. Wilson, Jr. 106
Duston, Arthur W. Memorial by Louis Roark 511

Eardley, A. J. Graphic Treatment of Folds in Three Dimensions 483
———. Sediments of Great Salt Lake, Utah 1305
Early Development of Drilling Practices in Kanawha County, West Virginia. By J. E. Billingsley 1088
Early Paleozoic Formations in Texas. By E. H. Sellards. Abstract 1703
East Indies, Geological History of. By J. H. F. Umbgrove 1
East Side Coalinga Extension. By L. S. Chambers. Abstract 1715
East Texas, Résumé of Development in, during 1937. By E. A. Wendlandt and C. L. Herold 728
Eastern Extension of the Wilmington Oil Field. By E. J. Bartosh. Abstract 1715
Eclipse Plate, Microscope, for Routine Index Determinations. Geological Note by Walter B. Lang 1278
Economic Aspects of Drilling. By Joseph E. Pogue 633
Economic Paleontologists and Mineralogists, Society of, a Division of the Association, Headquarters Office 594
Editor, Report of. By W. A. Ver Wiebe 600
Effect of Angularity of Grain on Porosity and Permeability of Unconsolidated Sands. Geological Note by Frederick G. Tickell and William N. Hiatt . 1272
Eleventh Annual Field Conference, Kansas Geological Society, September 2–6, 1937. Geological Note by Joseph L. Borden 100
Elms, Morris A. Volcanics of the Buck Hill Quadrangle, Brewster County, Texas. Abstract 1712
Emery, K. O., and Dietz, Robert S. Phosphorite on the Sea Floor Off Southern California. Abstract 1717
Eocene and Cretaceous Stratigraphy of Barrilla and Eastern Davis Mountains of Trans-Pecos Texas. By C. T. Jones 1423
Executive Committee Meetings 594
Exposure of the Red Mountain Fault, Ventura County. By Mason L. Hill and M. L. Natland. Abstract 1717

Faulting, Active, in Lavaca County, Texas. Geological Note by Douglas E. Bell and V. A. Brill 104

Fettke, Charles R. Oriskany as a Source of Gas and Oil in Pennsylvania and Adjacent Areas . . . 241
———. Review of The Flow of Homogeneous Fluids through Porous Media, by M. Muskat . . . 1282
Financial Statement, Division of Paleontology and Mineralogy, 1937. The Association Round Table . . . 334
Financial Statement, 1937. The Association Round Table . . . 329
Finch, E. H. First Geologic Work Fostered by United States Government . . . 1250
First Geologic Work Fostered by United States Government. By E. H. Finch 1250
Fisher, D. Jerome. Problem of Two Tilts and the Stereographic Projection . 1261
Fitzgerald, Jr., James. Texas-New Mexico Cross Sections. Abstracts . . . 1702
Florida, Mississippi, and Alabama, Subsurface Tertiary Zones of Correlation through. By Donald W. Gravell and Marcus A. Hanna . . . 984
———, Oil and Gas Possibilities in Atlantic Coastal Plain from New Jersey to. By Olive C. Postley . . . 799
Flow of Homogeneous Fluids through Porous Media. By M. Muskat. Review by Charles R. Fettke . . . 1282
Fluids in Oil Reservoirs, Behavior of. By T. V. Moore . . . 1237
Folds, Graphic Treatment of, in Three Dimensions. By A. J. Eardley . . . 483
Franklin Mountains of West Texas, Paleozoic Stratigraphy of. By L. A. Nelson. Abstract . . . 1704
Fresh-Water Resources of the Bolivar Coastal Fields. By J. G. Douglas. Abstract . . . 1103
Friendswood Field, Harris County, Texas. Geological Note by Olin G. Bell . 1602
Fritz, W. C. South-North Cross Section from Pecos County through Ector County, Texas, to Roosevelt County, New Mexico. Abstract . . . 1702
Frye, John C. New Interpretation of Monongahela-Dunkard Contact, Washington County, Ohio. Geological Note . . . 103
Fulda, Ernst. *Steinsalz und Kalisalze* (Rock Salt and Potash Salts). Review by R. D. Reed . . . 1284
Fulk, Frank F., and Giesey, Sam C. North Cowden Field, Ector County, Texas. Abstract . . . 1712
Fulton, L. J. Memorial of Clyde M. Becker . . . 1620
Fuqua, H. B. Future of the Geologist in the Petroleum Industry . . . 517
———. Report of President . . . 591
Further Data on Wildcat Drilling in 1937. By Frederic H. Lahee . . . 1231
Future of the Geologist in the Petroleum Industry. By H. B. Fuqua . . . 517

Garlough, J. L. Review of Origin of the Shoestring Sands of Greenwood and Butler Counties, Kansas, by N. Wood Bass . . . 1458
Gas, Natural, and Petroleum in Non-Marine Sediments of Powder Wash Field in Northwest Colorado. By W. T. Nightingale . . . 1020
———, Natural, in Appalachian Province, Regional Variations in Composition of. By Paul H. Price and A. J. W. Headlee . . . 1153
Gas and Oil in Michigan, Geologic Occurrence of. By B. F. Hake . . . 393
——— in Pennsylvania and Adjacent Areas, Oriskany as a Source of. By Charles R. Fettke . . . 241
Gas and Oil Possibilities in Atlantic Coastal Plain from New Jersey to Florida. By Olive C. Postley . . . 799
Gas and Oil Resources of Western Kansas. By Walter A. Ver Wiebe. Review by N. W. Bass. . . . 1287
Gas and Oil States East of the Mississippi River, and Some Producing States in the Mid-Continent Region, Bibliography of Geologic Structure Maps and Cross Sections of Areas in. By Olive C. Postley . . . 431
Gas Sands, Mississippian, of Central Michigan Area. By Edward W. Hard . 129
Geographic Distribution of Members . . . 596
Geologic Branch of the State Division of Mines, Progress of. By Olaf P. Jenkins. Abstract . . . 1714
Geologic Names and Correlations, Report of Committee on. By John G. Bartram . . . 604
Geologic Occurrence of Oil and Gas in Michigan. By B. F. Hake . . . 393
Geologic Relationships and Development of Appalachian Fields, History of. By George H. Ashley . . . 416

Geologic Section from Fisher County through Andrews County, Texas, to Eddy County, New Mexico. By Robert I. Dickey. Abstract 1702
Geologic Structure Maps and Cross Sections of Areas in Oil and Gas States East of the Mississippi River, and Some Producing States in the Mid-Continent Region, Bibliography of. By Olive C. Postley 431
Geologic Work, First, Fostered by United States Government. By E. H. Finch 1250
Geological Exploration, Aerial Photography for. By Louis V. Olson. Abstract 1706
Geological History of the South American Cordillera, Outlines of. By H. Gerth. Abstract 1102
——— of the East Indies. By J. H. F. Umbgrove 1
Geological Limitations to Oil Law. By William W. Porter, II 565
Geological Notes 100, 217, 306, 763, 915, 1101, 1272, 1447, 1600, 1687
Geological Succession of Central Venezuela. By M. Kamen Kaye . . 1224, 1605
Geologist, Future of, in the Petroleum Industry. By H. B. Fuqua 517
———, Petroleum, Rôle of, in Development of Law of Oil and Gas. By George A. Wilson 1080
Geologist and the Well-Spacing Problem. By Edgar Kraus 1440
Geology, an Introduction to. By A. E. Trueman. Review by John L. Rich . 1288
——— of Bellevue Oil Field, Bossier Parish, Louisiana. By A. F. Crider . . 1658
——— of El Valle de Guanape Area, District of Bruzual, Anzoategui. By K. F. Dallmus. Abstract 1104
——— of North-Central and Central Texas. By M. G. Cheney. Abstract . . 1703
——— of Soldado Rock between Venezuela and Trinidad. By H. Kugler. Abstract 1105
——— of Tepetate Oil Field, Acadia Parish, Louisiana. By Max Bornhauser and Fred W. Bates 285
——— of the Island Gran Roque and Its Phosphatic Deposits. By S. E. Aguerrevere and V. M. Lopez. Abstract 1105
——— of the Muskogee-Porum District, Muskogee and McIntosh Counties, Oklahoma. By Charles W. Wilson, Jr. Review by J. L. Borden 224
Geology and Biology of the San Carlos Mountains, Tamaulipas, Mexico. Directed by Lewis Burnett Kellum. Review by Philip B. King 319
Geology and Oil Development, Regional, of West Texas Permian Basin, Summary of. By Ed W. Owen. Abstract 1702
Geomorphic Provinces of California as Outlined on the New State Geologic Map. By Olaf P. Jenkins. Abstract 1717
Geophysikalische Reichsaufnehme als Grundlage für die Erschliessung neuer Lagerstätten (Geophysical Survey of the Reich as Background for Prospecting for Mineral Deposits). By O. Barsch. Review by Walter Kauenhowen . . 494
Georgia, Southern, Recent Petroleum Activities in Coastal Plain of. By A. C. Munyan 794
———, Stratigraphy of Coastal Plain of. By C. Wythe Cooke and Arthur C. Munyan 789
Gerth, H. Outlines of the Geological History of the South American Cordillera. Abstract 1102
Giesey, Sam C., and Fulk, Frank F. North Cowden Field, Ector County, Texas. Abstract 1712
Golden and Dry Creek Structures, Carbon County, Montana, Revision of Stratigraphy of. Geological Note by Charles W. Wilson, Jr. 106
Gonzalez de Juana, C. Contributions to the Geology of the Zulia-Falcon Basin. Abstract 1104
Gosport and Cockfield Formations, Eastern Mississippi and Western Alabama, Correlation of. Geological Note by B. W. Blanpied and Roy T. Hazzard . 309
Grabau, Amadeus W. Paleozoic Formations in the Light of the Pulsation Theory, Vol. III, Cambrovician Pulsation System. Review by Byron N. Cooper 934
Graphic Treatment of Folds in Three Dimensions. By A. J. Eardley . . . 483
Graptolites, Transcendent Value of, for Correlation, Demonstrated. Geological Note by Charles E. Decker 221
Gravell, Donald W., and Hanna, Marcus A. Subsurface Tertiary Zones of Correlation through Mississippi, Alabama, and Florida 984
Great Salt Lake, Utah, Sediments of. By A. J. Eardley 1305
Grimm, M. W. Shreveport Field, Caddo Parish, Louisiana. Geological Note . 1277
Ground Water. By C. F. Tolman. Review by O. E. Meinzer 490

Guadalupe Mountain Region, Relation of Permian Sedimentation to Tectonics in. By Philip B. King. Abstract 1707
Guadalupe Mountains as They Look to the Aerial Geologist. By Cary P. Butcher. Abstract 1706
Guarico, Some Alteration Products in Miocene Clays of. By G. D. Johnson. Abstract 1105
Gulf Coastal Developments in 1937. By O. L. Brace 736
Gulf Region and Western Interior Region, Comparison of Upper Cretaceous Deposits of. By Lloyd W. Stephenson and John B. Reeside, Jr. 1629

Haigh, Berte R., Bybee, H. P., and Cole, Taylor. Developments in West Texas and Southeastern New Mexico in 1937 694
Hake, B. F. Geologic Occurrence of Oil and Gas in Michigan 393
Hanna, G. Dallas, and Camp, Charles L. Methods in Paleontology. Review by Ralph D. Reed 317
Hanna, Marcus A. Wilcox Eocene Production at Segno Field, Polk County, and Cleveland Field, Liberty County, Texas. Geological Note 1274
Hanna, Marcus A., and Gravell, Donald W. Subsurface Tertiary Zones of Correlation through Mississippi, Alabama, and Florida 984
Hanna, Marcus A., and Wolf, Albert G. Aragonite in Texas and Louisiana Salt-Dome Cap Rocks. Geological Note 217
Hard, Edward W. Mississippian Gas Sands of Central Michigan Area . . . 129
Hardin, Meade, and Breckinridge Counties, Kentucky, Chester Rocks of. By Ralph E. Stouder 267
Harker's Solution Corrected—Problem of Secondary Tilt. By Edmund M. Spieker 1255
Harlton, Bruce H. Stratigraphy of the Bendian of the Oklahoma Salient of the Ouachita Mountains 852
Hartnagel, Chris A. Medina and Trenton of Western New York 79
Hazzard, Roy T., and Blanpied, B. W. Correlation of Cockfield and Gosport Formations, Eastern Mississippi and Western Alabama. Geological Note 309
Headlee, A. J. W., and Price, Paul H. Regional Variations in Composition of Natural Gas in Appalachian Province 1153
Headquarters Office 594
Hedberg, H. D. Second Venezuelan Geological Congress, San Cristobal, April 1–7, 1938: Abstracts. Geological Note 1101
Herold, C. L., and Wendlandt, E. A. Résumé of Development in East Texas during 1937 728
Herold, Stanley C. Criteria for Determining the Time of Accumulation Under Special Circumstances 834
Hiatt, William N., and Tickell, Frederick G. Effect of Angularity of Grain on Porosity and Permeability of Unconsolidated Sands. Geological Note . 1272
Hiestand, T. C. Studies of Insoluble Residues from "Mississippi Lime" of Central Kansas 1588
Hill, Mason L., and Natland, M. L. An Exposure of the Red Mountain Fault, Ventura County. Abstract 1717
Historical Document of Interest to Petroleum Geologists. Geological Note by Wilber Stout 1687
History of Development and Geologic Relationships of Appalachian Fields. By George H. Ashley 416
Hobson, H. D. Nature and Extent of Movement along the San Cayetano Fault, Ventura County, California. Abstract 1716
Hoffmeister, W. S. Aspect and Zonation of the Molluscan Fauna in the La Rosa and Lagunillas Formations, Bolivar Coastal Fields, Venezuela. Abstract 1104
Holarctic Correlation, Significance of Tertiary Mammalian Faunas in. By R. A. Stirton. Abstract 1717
Holston, A. A. Discovery of Oil in Bodcaw Sand, Cotton Valley Field, Webster Parish, Louisiana. Geological Note 1603
Homogeneous Fluids, the Flow of, through Porous Media. By M. Muskat. Review by Charles R. Fettke 1282
Honorary Members 1118, 1123
Hoots, Harold W. Discoveries and Additions to Oil Reserves in California during 1937 701
Hunt, E. H. Developments in Rocky Mountain Region in 1937 677

Hutchison, A. G. Note on the Cretaceous of Trinidad. Abstract 1105

Illinois, Recent Petroleum Development in. By Alfred H. Bell and George V. Cohee 649
———, Southeastern, Recent Oil Discoveries in. By Theron Wasson . . . 71
Index Determinations, Routine, Microscope Eclipse Plate for. Geological Note by Walter B. Lang 1278
Indies, East, Geological History of. By J. H. F. Umbgrove 1
Informal Symposium on Recent Petroleum Discoveries in California . . . 1715
Insoluble Residues from "Mississippi Lime" of Central Kansas, Studies of. By T. C. Hiestand 1588
Interior Region, Western, and Gulf Region, Comparison of Upper Cretaceous Deposits of. By Lloyd W. Stephenson and John B. Reeside, Jr. 1629
International Geological Congress, London, July 31–August 8, 1940. The Association Round Table 1299
International Union of Geodesy and Geophysics, Washington, D. C., September 4–15, 1939. The Association Round Table 1615
Interpretation, New, of Monongahela-Dunkard Contact, Washington County, Ohio. Geological Note by John C. Frye 103
Introduction to Geology. By A. E. Trueman. Review by John L. Rich. . . . 1288
Iran, Northern, Stratigraphy of. By Hubert G. Schenck. Abstract 1716
Irvine Oil Field, Estill County, Kentucky, Unexposed Silurian Section and Producing Zone of. Geological Note by Arthur C. McFarlan 1447
Israelsky, M. C. Cores from a Deep Well at Rodessa, Caddo Parish, Louisiana. Geological Note 764

Jackson, Mississippi, Deepest Rocks at. Discussion by Watson H. Monroe . 927
Jackson Gas Field and the State Deep Test Well. By Watson H. Monroe and Henry N. Toler. Abstract 1286
Jenkins, Olaf P. Geomorphic Provinces of California as Outlined on the New State Geologic Map. Abstract 1717
———. Progress of the Geologic Branch of the State Division of Mines. Abstract 1714
Jesse Pool, Pontotoc and Coal Counties, Oklahoma. By W. Baxter Boyd . . 1560
Johnson, Douglas W., Editor. Journal of Geomorphology. Review by Donald C. Barton 502
———. Studies in Scientific Method. Review by Donald C. Barton. . . . 502
Johnson, G. D. Some Alteration Products in Miocene Clays of Guarico. Abstract 1105
Jones, C. T. Cretaceous and Eocene Stratigraphy of Barrilla and Eastern Davis Mountains of Trans-Pecos Texas 1423
Journal of Geomorphology. Edited by Douglas W. Johnson. Review by Donald C. Barton 502

Kanawha County, West Virginia, Early Development of Drilling Practices in. By J. E. Billingsley 1088
Kansas, Central, Studies of Insoluble Residues from "Mississippi Lime" of. By T. C. Hiestand 1588
———, Developments in, in 1937. By Rycroft G. Moss 666
———, Origin of the Shoestring Sands of Greenwood and Butler Counties. By N. W. Bass. Review by J. L. Garlough 1458
Kansas City, Missouri, Subsurface Study of Cherokee Formation Near. Geological Note by Glenn G. Bartle 918
Kansas Geological Society, Eleventh Annual Field Conference, September 2–6, 1937. Geological Note by Joseph L. Borden 100
Kauenhowen, Walter. Review of *Der Untergrund von Schleswig-Holstein nach den Ergebnissen seismischer Refraktionsmessungen* (The Subsurface of Schleswig-Holstein in Light of Seismic Refraction Surveys), by H. Reich 494
———. Review of *Die Geophysikalische Reichsaufnehme als Grundlage für die Erschliessung neuer Lagerstätten* (Geophysical Survey of the Reich as Background for Prospecting for Mineral Deposits), by O. Barsch 494
Kaye, M. Kamen. Geological Succession of Central Venezuela 1224
Kehrer, L. Some Observations on the Stratigraphy of the States of Tachira and Merida in Southwestern Venezuela. Abstract 1103

Kellum, Lewis Burnett, Director. Geology and Biology of the San Carlos Mountains, Tamaulipas, Mexico. Review by Philip B. King 319
Kentucky, Chester Rocks of Meade, Hardin, and Breckinridge Counties. By Ralph E. Stouder 267
———, Eastern, Source of "Corniferous" Oil in. Geological Note by Ralph N. Thomas. 1452
———, Relation of Rough Creek Fault of, to Ouachita Deformation. By William L. Russell 1682
———, Unexposed Silurian Section and Producing Zone of Irvine Oil Field, Estill County. Geological Note by Arthur C. McFarlan 1447
King, Philip B. Relation of Permian Sedimentation to Tectonics in Guadalupe Mountain Region. Abstract 1707
———. Review of Geology and Biology of the San Carlos Mountains, Tamaulipas, Mexico, directed by Lewis Burnett Kellum 319
Knechtel, M. M. Pre-Cretaceous Rocks in the State of Barinas, Venezuela. Abstract 1105
Kraus, Edgar. The Geologist and the Well-Spacing Problem 1440
Kroenlein, George A. Salt, Potash, and Anhydrite in the Castile Formation of Southeast New Mexico. Abstract 1707
Kugler, H. Geology of Soldado Rock between Venezuela and Trinidad. Abstract 1105
Kundig, E. The Pre-Cretaceous Rocks of the Central Venezuelan Andes with Some Remarks about the Tectonics. Abstract. 1103

Laboratory Exercises in Physical Geology. By William C. Putnam and Robert W. Webb. Review by H. W. Straley, III 501
Lafferty, Robert C. The Oriskany in West Virginia 175
Lahee, Frederic H. Chapel Hill Pool, Smith County, Texas. Geological Note 1107
———. Further Data on Wildcat Drilling in 1937 1231
———. Report of Committee for Publication 614
———. Report of Representative to National Research Council. 615
———. Where Shall Our Young Graduates in Petroleum Geology Acquire Field Experience? The Association Round Table 1613
———. Wildcat Drilling in 1935 and 1936. Corrections 1236
———. Wildcat Drilling in 1937 645
Lamar County, Mississippi, Scanlan, or Midway Dome. By D. J. Munroe. . 816
Land of Sheba. By H. St. J. B. Philby. Review by C. H. Dane 1606
Lang, Walter B. Microscope Eclipse Plate for Routine Index Determinations. Geological Note 1278
Lasky, Samuel G. Newly Discovered Section of Trinity Age in Southwestern New Mexico 524
Law, Jan. Possible Structural Interpretation of the Area of New Development at Rosecrans. Abstract 1715
Law of Oil and Gas, Rôle of Petroleum Geologist in Development of. By George A. Wilson 1080
———, Oil, Geological Limitations to. By William W. Porter, II 565
Lawson, Andrew Cowper, Honorary Member. By C. L. Moody. The Association Round Table 1120
Leach, C. E., and May, J. C. Notes on the Santa Susana Thrust Fault, Los Angeles County, California. Abstract 1716
Leet, L. Don. Practical Seismology and Seismic Prospecting. Review by Donald C. Barton 1607
Lenticular Sand Bodies, Application of Principle of Differential Settling to Tracing of. By John L. Rich. 823
Lewis, Frank E. Stratigraphy of Upper and Middle Permian of West Texas and Southeast New Mexico. Abstract 1710
Limestone Reservoirs in the Permian Basin, Possible Nature of. Geological Note by H. P. Bybee 915
Limitations, Geological, to Oil Law. By William W. Porter, II 565
Linear Units, Proposed New Definition for. By R. M. Wilson. The Association Round Table 1616
Lloyd, E. Russell. Theory of Reef Barriers. Abstract 1709
Long Beach Oil Field, Northwestern Extension of. By Robin Willis. Abstract 1715
Los Angeles County, California, Wilmington Oil Field. By E. J. Bartosh . . 1048

Louisiana, Carterville-Sarepta and Shongaloo Fields, Bossier and Webster Parishes. By G. D. Thomas 1473
———, Cores from a Deep Well at Rodessa, Caddo Parish. Geological Note by M. C. Israelsky 764
———, Darrow Salt Dome, Ascension Parish. By Carroll E. Cook 1412
———, Discovery of Oil in Bodcaw Sand, Cotton Valley Field, Webster Parish. Geological Note by A. A. Holston 1603
———, Geology of Bellevue Oil Field, Bossier Parish. By A. F. Crider . . . 1658
———, Geology of Tepetate Oil Field, Acadia Parish. By Max Bornhauser and Fred W. Bates 285
———, North, and South Arkansas, Developments in, in 1937. By H. K. Shearer 719
———, Shreveport Field, Caddo Parish. Geological Note by M. W. Grimm 1277
———, Sugar Creek Field, Claiborne Parish. By C. C. Clark 1504
Louisiana and Texas Salt-Dome Cap Rocks, Aragonite in. Geological Note by Marcus A. Hanna and Albert G. Wolf 217

Macdonald, G. A., and Shepard, F. P. Sediments of Santa Monica Bay, California 201
McFarlan, Arthur C. Unexposed Silurian Section and Producing Zone of Irvine Oil Field, Estill County, Kentucky, Geological Note 1447
McMurray Oil Sands, Alberta, Origin of. By J. C. Sproule 1133
Manger, G. E. Notes on the Stratigraphy of the Younger Tertiary Formations of the District of Bolivar, State of Zulia, Venezuela. Abstract 1103
Maps, Geologic Structure, and Cross Sections of Areas in Oil and Gas States East of the Mississippi River, and Some Producing States in the Mid-Continent Region, Bibliography of. By Olive C. Postley 431
Martyn, Phil F. Refugio Oil and Gas Field, Refugio County, Texas . . . 1184
Maxson, John H. Miocene-Pliocene Boundary. Abstract 1716
May, J. C., and Leach, C. E. Notes on the Santa Susana Thrust Fault, Los Angeles County, California. Abstract 1716
Meade, Hardin, and Breckinridge Counties, Kentucky, Chester Rocks of. By Ralph E. Stouder 267
Medina and Trenton of Western New York. By Chris A. Hartnagel . . . 79
Meinzer, O. E. Review of Ground Water, by C. F. Tolman 490
Membership Applications Approved for Publication. The Association Round Table, ... 116, 229, 326, 391, 507, 576, 631, 781, 940, 1117, 1131, 1292, 1466, 1614, 1627, 1699, 1718
Membership List, March 4, 1938. The American Association of Petroleum Geologists 338, 1293
Memorial 509, 627, 1127, 1621
Methods in Paleontology. By Charles L. Camp and G. Dallas Hanna. Review by Ralph D. Reed 317
Mexico, Geology and Biology of the San Carlos Mountains, Tamaulipas. Directed by Lewis Burnett Kellum. Review by Philip B. King 319
———, Southwestern, Newly Discovered Section of Trinity Age in. By Samuel G. Lasky 524
Michigan, Geologic Occurrence of Oil and Gas in. By B. F. Hake 393
Michigan Area, Central, Mississippian Gas Sands of. By Edward W. Hard . 129
Michigan Basin, Recent Developments in. By E. A. Newman 659
Microscope Eclipse Plate for Routine Index Determinations. Geological Note by Walter B. Lang 1278
Mid-Continent Region, Bibliography of Geologic Structure Maps and Cross Sections of Areas in Oil and Gas States East of the Mississippi River, and Some Producing States in. By Olive C. Postley 431
Mid-Year Meeting, El Paso, Texas, September 27–October 2, 1938. The Association Round Table 625, 782, 943, 1122, 1297, 1701
———. Abstracts 1702
Midland Basin, Eastern, Texas, Stratigraphy. By Lincoln R. Page and John Emery Adams. Abstract 1709
Midway, or Scanlan, Dome, Lamar County, Mississippi. By D. J. Munroe . 816
Miller, A. K. Comparison of Permian Ammonoid Zones of Soviet Russia with Those of North America 1014
Miller, C. C. South Texas Section Tenth Annual Meeting, Corpus Christi, October 21–22, 1938 1712

Minutes, Twenty-Third Annual Business Meeting, Roosevelt Hotel, New Orleans, Louisiana, March 16–18, 1938. By Ira H. Cram. The Association Round Table 590
Miocene Clays of Guarico, Some Alteration Products in. By G. D. Johnson. Abstract 1105
Miocene-Pliocene Boundary. By John H. Maxson. Abstract 1716
Miser, Hugh D. N. H. Darton, Honorary Member. The Association Round Table 1118
Mississippi, Deepest Rocks at Jackson. Discussion by Watson H. Monroe . 927
———, Eastern, and Alabama, Western, Correlation of Cockfield and Gosport Formations. Geological Note by B. W. Blanpied and Roy T. Hazzard . 309
———, Scanlan, or Midway, Dome, Lamar County. By D. J. Munroe. . . 816
Mississippi, Alabama, and Florida, Subsurface Tertiary Zones of Correlation through. By Donald W. Gravell and Marcus A. Hanna 984
Mississippi and Alabama, Stratigraphy of Upper Cretaceous Series in. By L. W. Stephenson and W. H. Monroe 1639
"Mississippi Lime" of Central Kansas, Studies of Insoluble Residues from. By T. C. Hiestand 1588
Mississippi River, Bibliography of Geologic Structure Maps and Cross Sections of Areas in Oil and Gas States East of, and in Some Producing States in the Mid-Continent Region. By Olive C. Postley 431
Mississippian Gas Sands of Central Michigan Area. By Edward W. Hard . . 129
Missouri, Subsurface Study of Cherokee Formation Near Kansas City. Geological Note by Glenn G. Bartle 918
Molluscan Fauna in the La Rosa and Lagunillas Formations, Bolivar Coastal Fields, Venezuela, Aspect and Zonation of. By W. S. Hoffmeister. Abstract 1104
Monongahela-Dunkard Contact, Washington County, Ohio, New Interpretation of. Geological Note by John C. Frye 103
Monroe, Watson H. Deepest Rocks at Jackson, Mississippi. Discussion . . 927
Monroe, W. H., and Stephenson, L. W. Stratigraphy of Upper Cretaceous Series in Mississippi and Alabama 1639
Monroe, Watson H., and Toler, Henry N. The Jackson Gas Field and the State Deep Test Well. Abstract 1286
Montana, Revision of Stratigraphy of Dry Creek and Golden Structures, Carbon County. Geological Note by Charles W. Wilson, Jr. 106
Monument Field, Lea County, New Mexico. By W. D. Anderson and James R. Day. Abstract 1711
Moody, C. L. Andrew Cowper Lawson, Honorary Member. The Association Round Table 1120
———. Twenty-Third Annual Meeting, The American Association of Petroleum Geologists, Roosevelt Hotel, New Orleans, Louisiana, March 16–18, 1938. The Association Round Table 577
Moore, T. V. Behavior of Fluids in Oil Reservoirs. 1237
Moss, Rycroft G. Developments in Kansas in 1937 666
Mossom, Stuart. Activities in South Texas, 1937–1938 750
Movement along San Cayetano Fault, Ventura County, California, Nature and Extent of. By H. D. Hobson. Abstract. 1716
Muir, John Malcolm. Memorial by Paul Weaver 509
Müller, Theodor. *Das marine Paläozän und Eozän in Norddeutschland und Südskandinavien, mit einer Zusammenstellung der gesamten Literatur* (Marine Paleocene and Eocene of North Germany and South Scandinavia, with an Exhaustive Bibliography). Review by Ralph D. Reed 315
Munroe, D. J. Scanlan, or Midway Dome, Lamar County, Mississippi . . 816
Munyan, Arthur C. Recent Petroleum Activities in Coastal Plain of Southern Georgia 794
Munyan, Arthur C., and Cooke, C. Wythe. Stratigraphy of Coastal Plain of Georgia 789
Muskat, M. The Flow of Homogeneous Fluids through Porous Media. Review by Charles R. Fettke 1282
Muskogee-Porum District, Muskogee and McIntosh Counties, Oklahoma, Geology of. By Charles W. Wilson, Jr. Review by J. L. Borden . . . 224

Naming Subsurface Formations. Discussion by Ronald K. DeFord 1280
National Research Council. Report of the Committee on Sedimentation, 1936–1937. Review by Donald C. Barton 223

Natland, M. L., and Hill, Mason L. An Exposure of the Red Mountain Fault, Ventura County. Abstract 1717
Nature and Extent of Movement along the San Cayetano Fault, Ventura County, California. By H. D. Hobson. Abstract 1716
Navarro Crossing Field, Houston County, Texas, Geological Note by E. B. Wilson 1600
Needham, C. E. Correlation of the Pennsylvanian Rocks of New Mexico. Abstract 1705
Nelson, L. A. Paleozoic Stratigraphy of the Franklin Mountains of West Texas. Abstract 1704
New Development at the Potrero Oil Field. By Robin Willis. Abstract. . . 1715
——— in the Southeastern Extension of the Torrance Oil Field. By Richard G. Reese. Abstract 1715
New Jersey to Florida, Oil and Gas Possibilities in Atlantic Coastal Plain from. By Olive C. Postley 799
New Mexico, Correlation of the Pennsylvanian Rocks of. By C. E. Needham. Abstract 1705
———, Geologic Cross Section from Fisher County through Andrews County, Texas, to Eddy County. By Robert I. Dickey. Abstract. 1702
———, Monument Field, Lea County. By W. D. Anderson and James R. Day. Abstract 1711
———, Southeast, and West Texas, Stratigraphy of Upper and Middle Permian of. By Frank E. Lewis. Abstract 1710
———, Southeast, Salt, Potash, and Anhydrite in the Castile Formation of. By George A. Kroenlein. Abstract 1707
———, Southeastern, and West Texas, Developments in, in 1937. By H. P. Bybee, Berte R. Haigh, and Taylor Cole 694
———, South-North Cross Section from Pecos County, through Ector County, Texas, to Roosevelt County. By W. C. Fritz. Abstract 1702
———, South-North Cross Section from Pecos County, through Winkler County, Texas, to Roosevelt County. By E. H. Woods. Abstract 1702
———, Surface and Subsurface Formations, Eddy County. By Ronald K. DeFord. Abstract 1706
New York, Western, Medina and Trenton of. By Chris A. Hartnagel . . . 79
Newhall-Potrero Oil Field. By Richard W. Sherman. Abstract 1715
Newly Discovered Section of Trinity Age in Southwestern New Mexico. By Samuel G. Lasky 524
Newman, E. A. Recent Developments in Michigan Basin 659
Nightingale, W. T. Petroleum and Natural Gas in Non-Marine Sediments of Powder Wash Field in Northwest Colorado 1020, 1604
Noble, E. B. Rio Bravo Oil Field. Abstract. 1715
Non-Marine Sediments of Powder Wash Field in Northwest Colorado, Petroleum and Natural Gas in. By W. T. Nightingale 1020, 1604
North America, Comparison of Permian Ammonoid Zones of Soviet Russia with Those of. By A. K. Miller 1014
North Cowden Field, Ector County, Texas. By Sam C. Giesey and Frank F. Fulk. Abstract 1712
Northwestern Extension of the Long Beach Oil Field. By Robin Willis. Abstract 1715
Notes on the Santa Susana Thrust Fault, Los Angeles County, California. By C. E. Leach and J. C. May. Abstract 1716

Observations on the Stratigraphy of the States of Tachira and Merida in Southwestern Venezuela. By L. Kehrer. Abstract 1103
Officers, New, of the Association. The Association Round Table. 581
Ohio Petroleum Company, Prospectus of. An Historical Document. Review by Wilber Stout 1687
Oil and Gas in Michigan, Geologic Occurrence of. By B. F. Hake 393
——— in Pennsylvania and Adjacent Areas, Oriskany as a Source of. By Charles R. Fettke 241
———, Rôle of Petroleum Geologist in Development of Law of. By George A. Wilson 1080
Oil and Gas Possibilities in Atlantic Coastal Plain from New Jersey to Florida. By Olive C. Postley 799

Oil and Gas Resources of Western Kansas. By Walter A. Ver Wiebe. Review by N. W. Bass . . . 1287
Oil and Gas States East of the Mississippi River, and Some Producing States in the Mid-Continent Region, Bibliography of Geologic Structure Maps and Cross Sections of Areas in. By Olive C. Postley . . . 431
Oil Development and Geology, Regional, of West Texas Permian Basin, Summary of. By Ed W. Owen. Abstract . . . 1702
Oil Discoveries, Recent, in Southeastern Illinois. By Theron Wasson . . . 71
Oil Fields, Russian, in 1937. By Basil B. Zavoico . . . 758
Oil Finding, Discovery Rates in. Discussion by F. F. Campbell . . . 109
Oil Law, Geological Limitations to. By William W. Porter, II . . . 565
Oil Reserves in California, Discoveries and Additions to, during 1937. By Harold W. Hoots . . . 701
Oil Reservoirs, Behavior of Fluids in. By T. V. Moore . . . 1237
Oil Sands, McMurray, Alberta, Origin of. By J. C. Sproule . . . 1133
Oklahoma, Deep Well near Marlow, Stephens County. Geological Note by E. A. Paschal . . . 1106
———, Geology of Muskogee-Porum District, Muskogee and McIntosh Counties. By Charles W. Wilson, Jr. Review by J. L. Borden . . . 224
———, Jesse Pool, Pontotoc and Coal Counties. By W. Baxter Boyd . . . 1560
———, Olympic Pool, Hughes and Okfuskee Counties. By Allen W. Tillotson 1579
Oklahoma Salient of the Ouachita Mountains, Stratigraphy of the Bendian of. By Bruce H. Harlton . . . 852
Olson, Louis V. Aerial Photography for Geological Exploration. Abstract . . . 1706
Olympic Pool, Hughes and Okfuskee Counties, Oklahoma. By Allen W. Tillotson . . . 1579
Origin of Association Committees. The Association Round Table . . . 1616
——— of McMurray Oil Sands, Alberta. By J. C. Sproule . . . 1133
——— of Red Sea Depression. By L. Owen . . . 1217
——— of Shoestring Sands of Greenwood and Butler Counties, Kansas. By N. Wood Bass. Review by J. L. Garlough . . . 1458
Oriskany as a Source of Gas and Oil in Pennsylvania and Adjacent Areas. By Charles R. Fettke . . . 241
——— in West Virginia. By Robert C. Lafferty . . . 175
Oriskany Sand Symposium. By Appalachian Geological Society. Review by Elizabeth E. Stephenson . . . 222
Oriskany Sandstone, Conditions of Sedimentation and Sources of, as Indicated by Petrology. Discussion by Arthur B. Cleaves . . . 1108
———, Sources of, and Conditions of Sedimentation as Indicated by Petrology. By Marcellus H. Stow . . . 541
Ouachita Deformation, Relation of Rough Creek Fault of Kentucky to. By William L. Russell . . . 1682
Ouachita Mountains, Stratigraphy of the Bendian of the Oklahoma Salient of. By Bruce H. Harlton . . . 852
Outlines of the Geological History of the South American Cordillera. By H. Gerth. Abstract . . . 1102
Owen, Ed W. Summary of Regional Geology and Oil Development of West Texas Permian Basin. Abstract . . . 1702
Owen, L. Origin of Red Sea Depression . . . 1217

Pacific Section Fifteenth Annual Meeting, Los Angeles, November 3–4, 1938. Abstracts. Roy M. Barnes . . . 1714
Page, Lincoln R., and Adams, John Emery. Stratigraphy, Eastern Midland Basin, Texas. Abstract . . . 1709
Paleontology, Methods in. By Charles L. Camp and G. Dallas Hanna. Review by Ralph D. Reed . . . 317
Paleozoic, Upper, Chinati Series, Presidio County, Texas. Geological Note by John W. Skinner . . . 924
Paleozoic Formations in the Light of the Pulsation Theory, Vol. III, Cambrovician Pulsation System. By Amadeus W. Grabau. Review by Byron N. Cooper . . . 934
Paleozoic Stratigraphy of the Franklin Mountains of West Texas. By L. A. Nelson. Abstract . . . 1704

Paschal, E. A. Deep Well near Marlow, Stephens County, Oklahoma. Geological Note . . . 1106
Past Officers of Association . . . 392
Patton, Leroy T. Custer Formation of Texas. Discussion . . . 925
Pennsylvania and Adjacent Areas, Oriskany as a Source of Gas and Oil in. By Charles R. Fettke . . . 241
Pennsylvanian Rocks of New Mexico, Correlation of. By C. E. Needham. Abstract . . . 1705
Permian, Upper and Middle, of West Texas and Southeast New Mexico, Stratigraphy of. By Frank E. Lewis. Abstract . . . 1710
Permian Ammonoid Zones of Soviet Russia, Comparison of, with Those of North America. By A. K. Miller . . . 1014
Permian Basin, Possible Nature of Limestone Reservoirs in. Geological Note by H. P. Bybee . . . 915
Permian Conference, Pre-Congress, in the U.S.S.R. Discussion by James Steele Williams . . . 771
Permian Sedimentation, Relation of, to Tectonics in Guadalupe Mountain Region. By Philip B. King. Abstract . . . 1707
Petroleum, the Science of. Review by W. A. Ver Wiebe . . . 777
Petroleum Activities, Recent, in Coastal Plain of Southern Georgia. By A. C. Munyan . . . 794
Petroleum and Natural Gas in Non-Marine Sediments of Powder Wash Field in Northwest Colorado. By W. T. Nightingale . . . 1020, 1604
Petroleum Development and Technology, 1938. By A.I.M.M.E. Petroleum Division. Review by Harry H. Power . . . 1457
Petroleum Development in Illinois, Recent. By Alfred H. Bell and George V. Cohee . . . 649
Petroleum Geologist, Rôle of, in Development of Law of Oil and Gas. By George A. Wilson . . . 1080
Petroleum Geologists, an Historical Document of Interest to. Geological Note by Wilber Stout . . . 1687
Petroleum Industry, Future of the Geologist in. By H. B. Fuqua . . . 517
Petroleum Technology, 1937, Annual Reviews of. Review by Eugene A. Stephenson . . . 1693
Petrology, Conditions of Sedimentation and Sources of the Oriskany Sandstone as Indicated by. By Marcellus H. Stow . . . 541
Philby, H. St. J. B. The Land of Sheba. Review by C. H. Dane . . . 1606
Phosphatic Deposits, Geology of the Island Gran Roque and Its. By S. E. Aguerrevere and V. M. Lopez. Abstract . . . 1105
Phosphorite on the Sea Floor Off Southern California. By Robert S. Dietz and K. O. Emery. Abstract . . . 1717
Pogue, Joseph E. Economic Aspects of Drilling . . . 633
Porosity and Permeability of Unconsolidated Sands, Effect of Angularity of Grain on. Geological Note by Frederick G. Tickell and William N. Hiatt . . . 1272
Porter II, William W. Geological Limitations to Oil Law . . . 565
Possible Nature of Limestone Reservoirs in the Permian Basin. Geological Note by H. P. Bybee . . . 915
Possible Structural Interpretation of the Area of New Development at Rosecrans. By Jan Law. Abstract . . . 1715
Postley, Olive C. Bibliography of Geologic Structure Maps and Cross Sections of Areas in Oil and Gas States East of the Mississippi River, and Some Producing States in the Mid-Continent Region . . . 431
———. Oil and Gas Possibilities in Atlantic Coastal Plain from New Jersey to Florida . . . 799
Potash Salts and Rock Salt. By Ernst Fulda. Review by R. D. Reed . . . 1284
Potrero Oil Field, New Development at. By Robin Willis. Abstract . . . 1715
Powder Wash Field, Colorado, Water Analysis. By W. T. Nightingale. Discussion by L. C. Case . . . 1604
——— in Northwest Colorado, Petroleum and Natural Gas in Non-Marine Sediments of. By W. T. Nightingale . . . 1020, 1604
Power, Harry H. Review of Petroleum Development and Technology, 1938, by A.I.M.M.E. Petroleum Division . . . 1457
Powers, Elliot H. Sand Hills Area, Western Crane County, Texas. Abstract 1704

Practical Repressuring. By Newell M. Wilder 189
Practical Seismology and Seismic Prospecting. By L. Don Leet. Review by Donald C. Barton. 1607
Pratt, Wallace E. Thirty-Year Oil Fields. Editorial. The Association Round Table 1698
Pre-Congress Permian Conference in the U.S.S.R. Discussion by James Steele Williams 771
Pre-Cretaceous Rocks in the State of Barinas, Venezuela. By M. M. Knechtel. Abstract 1105
——— of the Central Venezuelan Andes with Some Remarks about the Tectonics. By E. Kundig. Abstract 1103
President, Report of. By H. B. Fuqua 591
Price, Paul H. Anticlinal Theory and Later Developments in West Virginia 1097
Price, Paul H., and A. J. W. Headlee. Regional Variations in Composition of Natural Gas in Appalachian Province 1153
Problem of Secondary Tilt—Harker's Solution Corrected. By Edmund M. Spieker 1255
——— of Two Tilts and the Stereographic Projection. By D. Jerome Fisher 1261
Producing Zone and Unexposed Silurian Section of Irvine Oil Field, Estill County, Kentucky. Geological Note by Arthur C. McFarlan 1447
Progress of the Geologic Branch of the State Division of Mines. By Olaf P. Jenkins. Abstract 1714
Proposed New Definition for Linear Units. By R. M. Wilson. The Association Round Table 1616
Putnam, William C., and Webb, Robert W. Laboratory Exercises in Physical Geology. Review by H. W. Straley, III 501

Quiriquire Field, Notes on. By J. H. Regan. Abstract. 1105

Recent Developments in Michigan Basin. By E. A. Newman 659
Recent Oil Discoveries in Southeastern Illinois. By Theron Wasson. 71
Recent Petroleum Activities in Coastal Plain of Southern Georgia. By A. C. Munyan 794
Recent Petroleum Development in Illinois. By Alfred H. Bell and George V. Cohee 649
Recent Publications . . 112, 225, 322, 503, 574, 779, 936, 1114, 1288, 1461, 1608,
Red Mountain Fault, Ventura County, an Exposure of. By Mason L. Hill and M. L. Natland. Abstract 1717
Red Sea Depression, Origin of. By L. Owen 1217
Reed, R. D. Review of Bibliography of West Indian Geology, by L. M. R. Rutten 1460
———. Review of *Das marine Paläozän und Eozän in Norddeutschland und Südskandinavien, mit einer Zusammenstellung der gesamten Literatur* (Marine Paleocene and Eocene of North Germany and South Scandinavia, with an Exhaustive Bibliography), by Theodor Müller 315
———. Review of *Die deutschen Alpen und ihre Enstehung* (The German Alps and Their Origin), by Max Richter. 1112
———. Review of Methods in Paleontology, by Charles L. Camp and G. Dallas Hanna 317
———. Review of *Regional Geologie der Erde* (Regional Geology of the Earth), edited by K. Andree, H. A. Brouwer, and W. H. Bucher 929
———. Review of Scientific Illustration, by John L. Ridgway 500
———. Review of *Steinsalz und Kalisalze* (Rock Salt and Potash Salts), by Ernst Fulda 1284
Reef Barriers, Theory of. By E. Russell Lloyd. Abstract 1709
Reese, Richard G. New Development in the Southeastern Extension of the Torrance Oil Field. Abstract. 1715
Reeside, Jr., John B., and Stephenson, Lloyd W. Comparison of Upper Cretaceous Deposits of Gulf Region and Western Interior Region 1629
Refugio Oil and Gas Field, Refugio County, Texas. By Phil F. Martyn . . 1184
Regan, J. H. Notes on the Quiriquire Field. Abstract 1105
Regional Geologie der Erde (Regional Geology of the Earth). Edited by K. Andree, H. A. Brouwer, and W. H. Bucher. Review by R. D. Reed . . 929

Regional Variations in Composition of Natural Gas in Appalachian Province. By Paul H. Price and A. J. W. Headlee . . . 1153
Reich, H. *Der Undergrund von Schleswig-Holstein nach den Ergebnissen seismischer Refraktionsmessungen* (The Subsurface of Schleswig-Holstein in Light of Seismic Refraction Surveys). Review by Walter Kauenhowen . 494
Relation of Permian Sedimentation to Tectonics in Guadalupe Mountain Region. By Philip B. King. Abstract . . . 1707
Relation of Rough Creek Fault of Kentucky to Ouachita Deformation. By William L. Russell . . . 1682
Report (Minutes) of Business Committee. By Ira H. Cram . . . 602
——— of Committee for Publication. By Frederic H. Lahee . . . 614
——— of Committee on Applications of Geology. By Frank R. Clark . . . 611
——— of Committee on Geologic Names and Correlations. By John Bartram 604
——— of Committee on Sedimentation, 1936–1937, National Research Council. Review by Donald C. Barton . . . 223
——— of Editor, By W. A. Ver Wiebe . . . 600
——— of President, By H. B. Fuqua . . . 591
——— of Representative to National Research Council. By Frederic H. Lahee 615
——— of Research Committee. By Donald C. Barton . . . 605
——— of Resolutions Committee. By Alexander Deussen . . . 616
——— of Secretary-Treasurer, By Ira H. Cram . . . 593
———, Second Annual, on Study of Time of Origin and Accumulation of Petroleum Submitted to Research Committee. By F. M. Van Tuyl and Ben H. Parker . . . 609
———, Supplementary. By Donald C. Barton . . . 608
Repressuring, Practical. By Newell M. Wilder . . . 189
Research Committee, Report of. By Donald C. Barton . . . 605
Reservoirs, Limestone, in the Permian Basin, Possible Nature of. Geological Note by H. P. Bybee . . . 915
Resolutions Committee, Report of. By Alexander Deussen . . . 616
Résumé of Development in East Texas during 1937. By E. A. Wendlandt and C. L. Herold . . . 728
Reviews . . . 111, 222, 315, 490, 777, 929, 1112, 1282, 1457, 1606, 1692
Revision of Stratigraphy of Dry Creek and Golden Structures, Carbon County, Montana. Geological Note by Charles W. Wilson, Jr. . . . 106
Rich, John L. Application of Principle of Differential Settling to Tracing of Lenticular Sand Bodies . . . 823
———. Review of An Introduction to Geology, by A. E. Trueman . . . 1288
Richter, Max. *Die deutschen Alpen und ihre Enstehung* (The German Alps and Their Origin). Review by R. D. Reed . . . 1112
Ridgway, John L. Scientific Illustration. Review by R. D. Reed . . . 500
Rio Bravo Oil Field. By E. B. Noble. Abstract . . . 1715
Roark, Louis. Memorial of Arthur W. Duston . . . 511
Rock Salt and Potash Salts. By Ernst Fulda. Review by R. D. Reed . . . 1284
Rocky Mountain Region, Developments in, in 1937. By E. H. Hunt . . . 677
Rôle of Petroleum Geologist in Development of Law of Oil and Gas. By George A. Wilson . . . 1080
Rosecrans, Possible Structural Interpretation of the Area of New Development at. By Jan Law. Abstract . . . 1715
Rough Creek Fault of Kentucky, Relation of, to Ouachita Deformation. By William L. Russell . . . 1682
Russell, William L. Relation of Rough Creek Fault of Kentucky to Ouachita Deformation . . . 1682
Russia, Soviet, Comparison of Permian Ammonoid Zones of, with Those of North America. By A. K. Miller . . . 1014
Russian Oil Fields in 1937. By Basil B. Zavoico . . . 758
Rutten, L. M. R. Bibliography of West Indian Geology. Review by R. D. Reed 1460

Salt-Dome Cap Rocks, Texas and Louisiana, Aragonite in. Geological Note by Marcus A. Hanna and Albert G. Wolf . . . 217
Salt, Potash, and Anhydrite in the Castile Formation of Southeast New Mexico By George A. Kroenlein. Abstract . . . 1707
San Cayetano Fault, Ventura County, California, Nature and Extent of Move-

ment along. By H. D. Hobson. Abstract 1716
Sand Hills Area, Western Crane County, Texas. By Elliot H. Powers. Abstract 1704
Santa Monica Bay, California, Sediments of. By F. P. Shepard and G. A. Macdonald 201
Santa Susana Thrust Fault, Los Angeles County, California, Notes on. By C. E. Leach and J. C. May. Abstract 1716
Scanlan, or Midway, Dome, Lamar County, Mississippi. By D. J. Munroe . 816
Schenck, Hubert G. Stratigraphy of Northern Iran. Abstract 1716
Science of Petroleum. Review by W. A. Ver Wiebe 777
Scientific Illustration. By John L. Ridgway. Review by R. D. Reed . . . 500
Second Annual Report on Study of Time of Origin and Accumulation of Petroleum Submitted to Research Committee. By F. M. Van Tuyl and Ben H. Parker 609
Second Venezuelan Geological Congress, San Cristobal, April 1–7, 1938: Abstracts. Geological Note by H. D. Hedberg 1101
Secondary Tilt, Problem of—Harker's Solution Corrected. By Edmund M. Spieker 1255
Secretary-Treasurer, Report of. By Ira H. Cram 593
Sediment-Heft (Symposium on Sediments). Review by Parker D. Trask . . 1692
Sedimentation, Conditions of, and Sources of the Oriskany Sandstone as Indicated by Petrology. By Marcellus H. Stow 541
Sediments of Great Salt Lake, Utah. By A. J. Eardley 1305
——— of Santa Monica Bay, California. By F. P. Shepard and G. A. Macdonald 201
Segno Field, Polk County, and Cleveland Field, Liberty County, Texas, Wilcox Eocene Production at. Geological Note by Marcus A. Hanna 1274
Seismology, Practical, and Seismic Prospecting. By L. Don Leet. Review by Donald C. Barton 1607
Sellards, E. H. Early Paleozoic Formations in Texas. Abstract 1703
Seventeenth International Geological Congress, Moscow, July–August, 1937. By J. Elmer Thomas. The Association Round Table 119
Shearer, H. K. Developments in South Arkansas and North Louisiana in 1937 . 719
Sheba, the Land of. By H. St. J. B. Philby. Review by C. H. Dane . . . 1606
Shepard, Francis P. Structural Trends Off the California Coast. Abstract . . 1716
Shepard, F. P., and Macdonald, G. A. Sediments of Santa Monica Bay, California 201
Sherman, Richard W. Newhall-Potrero Oil Field. Abstract 1715
Shoestring Sands of Greenwood and Butler Counties, Kansas, Origin of. By N. Wood Bass. Review by J. L. Garlough 1458
Shongaloo and Carterville-Sarepta Fields, Bossier and Webster Parishes, Louisiana. By G. D. Thomas 1473
Shreveport Field, Caddo Parish, Louisiana. Geological Note by M. W. Grimm . 1277
Significance of Tertiary Mammalian Faunas in Holarctic Correlation. By R. A. Stirton. Abstract 1717
Silurian Section, Unexposed, and Producing Zone of Irvine Oil Field, Estill County, Kentucky. Geological Note by Arthur C. McFarlan 1447
Skinner, John W. Upper Paleozoic Chinati Series, Presidio County, Texas. Geological Note 924
———. Upper Paleozoic Section of Chinati Mountains, Presidio County, Texas. Abstract 1705
Snider, L. B. Memorial of Ivan Vincent Bentz 1127
Soldado Rock between Venezuela and Trinidad, Geology of. By H. Kugler. Abstract 1105
Source of "Corniferous" Oil in Eastern Kentucky. Geological Note by Ralph N. Thomas. 1452
Sources of the Oriskany Sandstone and Conditions of Sedimentation as Indicated by Petrology. By Marcellus H. Stow 541
South American Cordillera. Outlines of the Geological History of. By H. Gerth. Abstract 1102
South Arkansas Stratigraphy with Emphasis on the Older Coastal Plain Beds. By Warren B. Weeks 953
South-North Cross Section from Pecos County through Ector County, Texas, to Roosevelt County, New Mexico. By W. C. Fritz. Abstract 1702

——— from Pecos County through Winkler County, Texas, to Roosevelt County, New Mexico. By E. H. Woods. Abstract 1702
South Texas, Activities in, 1937–1938. By Stuart Mossom 750
South Texas Section Tenth Annual Meeting, Corpus Christi, October 21–22, 1938. By C. C. Miller 1712
Southern California, Phosphorite on the Sea Floor Off. By Robert S. Dietz and K. O. Emery. Abstract 1717
Sparks, Dale Darrell Dolson. Memorial by Cevat Eyup Taşman 627
Spieker, Edmund M. Problem of Secondary Tilt—Harker's Solution Corrected 1255
Sproule, J. C. Origin of McMurray Oil Sands. Alberta 1133
State Deep Test Well and Jackson Gas Field. By Watson H. Monroe and Henry N. Toler. Abstract 1286
State Division of Mines, Progress of the Geologic Branch of. By Olaf P. Jenkins. Abstract 1714
Steinsalz und Kalisalze (Rock Salt and Potash Salts). By Ernst Fulda. Review by R. D. Reed 1284
Stephenson, Elizabeth E. Review of The Oriskany Sand Symposium, by Appalachian Geological Society 222
Stephenson, Eugene A. Review of Annual Reviews of Petroleum Technology, 1937 1693
Stephenson, L. W., and Monroe, W. H. Stratigraphy of Upper Cretaceous Series in Mississippi and Alabama 1639
Stephenson, Lloyd W., and Reeside, Jr., John B. Comparison of Upper Cretaceous Deposits of Gulf Region and Western Interior Region 1629
Stereographic Projection, Problem of Two Tilts and. By D. Jerome Fisher . 1261
Stevens, Clayton, and Bowles, T. K. Canal Oil Field. Abstract 1715
Stirton, R. A. Significance of Tertiary Mammalian Faunas in Holarctic Correlation. Abstract 1717
Stouder, Ralph E. Chester Rocks of Meade, Hardin, and Breckinridge Counties, Kentucky 267
Stout, Wilber. An Historical Document of Interest to Petroleum Geologists. Geological Note 1687
Stow, Marcellus H. Conditions of Sedimentation and Sources of the Oriskany Sandstone as Indicated by Petrology 541
Straley, III, H. W. Review of Laboratory Exercises in Physical Geology, by William C. Putnam and Robert W. Webb 501
Stratigraphic Names, Use of. Geological Note by John G. Bartram . . . 763
Stratigraphy, Cretaceous and Eocene, of Barrilla and Eastern Davis Mountains of Trans-Pecos Texas. By C. T. Jones 1423
———, Eastern Midland Basin, Texas. By Lincoln R. Page and John Emery Adams. Abstract 1709
——— of Coastal Plain of Georgia. By C. Wythe Cooke and Arthur C. Munyan 789
——— of Cretaceous Formations in the Neighborhood of the Rio Carache Valley, State of Trujillo. By W. G. C. Tomalin. Abstract 1103
——— of Dry Creek and Golden Structures, Carbon County, Montana, Revision of. Geological Note by Charles W. Wilson, Jr. 106
——— of Northern Iran. By Hubert G. Schenck. Abstract 1716
——— of the Bendian of the Oklahoma Salient of the Ouachita Mountains. By Bruce H. Harlton 852
——— of the States of Tachira and Merida in Southwestern Venezuela, Some Observations on the. By L. Kehrer. Abstract 1103
——— of the Upper and Middle Permian of West Texas and Southeast New Mexico. By Frank E. Lewis. Abstract 1710
——— of the Younger Tertiary Formations of the District of Bolivar, State of Zulia, Venezuela, Notes on. By G. E. Manger. Abstract 1103
——— of Upper Cretaceous Series in Mississippi and Alabama. By L. W. Stephenson and W. H. Monroe 1639
———, Revision of, of Dry Creek and Golden Structures, Carbon County, Montana. Geological Note by Charles W. Wilson, Jr. 106
———, South Arkansas, with Emphasis on the Older Coastal Plain Beds. By Warren B. Weeks 953
Stratigraphy and Structural History of East-Central United States. By Norval Ballard 1519

Structural History and Stratigraphy of East-Central United States. By Norval Ballard . . . 1519
Structural Interpretation, Possible, of the Area of New Development at Rosecrans. By Jan Law. Abstract . . . 1715
Structural Trends Off the California Coast. By Francis P. Shepard. Abstract . 1716
Studies in Scientific Method. By Douglas W. Johnson. Review by Donald C. Barton . . . 502
——— of Insoluble Residues from "Mississippi Lime" of Central Kansas. By T. C. Hiestand . . . 1588
Subsurface and Surface Formations, Eddy County, New Mexico. By Ronald K. DeFord. Abstract . . . 1706
Subsurface Formations, Naming. Discussion by Ronald K. DeFord. . . . 1280
Subsurface Study of Cherokee Formation Near Kansas City, Missouri. Geological Note by Glenn G. Bartle . . . 918
Subsurface Tertiary Zones of Correlation through Mississippi, Alabama, and Florida. By Donald W. Gravell and Marcus A. Hanna . . . 984
Sugar Creek Field, Claiborne Parish, Louisiana. By C. C. Clark . . . 1504
Summary of Regional Geology and Oil Development of the West Texas Permian Basin. By Ed W. Owen. Abstract . . . 1702
Supplementary Membership List, September 1, 1938. The Association Round Table . . . 1293
Supplementary Report of Research Committee. By Donald C. Barton . . . 608
Surface and Subsurface Formations, Eddy County, New Mexico, By Ronald K. DeFord. Abstract . . . 1706
Symposium, Informal, on Recent Petroleum Discoveries in California . . . 1715
———, Oriskany Sand. By Appalachian Geological Society. Review by Elizabeth E. Stephenson . . . 222

Tachira and Merida, States of, in Southwestern Venezuela, Some Observations on the Stratigraphy of. By L. Kehrer. Abstract . . . 1103
Tamaulipas, Mexico, Geology and Biology of the San Carlos Mountains. Directed by Lewis Burnett Kellum. Review by Philip B. King . . . 319
Taşman, Cevat Eyup. Memorial of Dale Darrell Dolson Sparks . . . 627
Tepetate Oil Field, Acadia Parish, Louisiana, Geology of. By Max Bornhauser and Fred W. Bates . . . 285
Tertiary Formations, Younger, of the District of Bolivar, State of Zulia, Venezuela, Notes on the Stratigraphy of. By G. E. Manger. Abstract . . . 1103
Tertiary Mammalian Faunas in Holarctic Correlation, Significance of. By R. A. Stirton. Abstract . . . 1717
Tertiary Zones, Subsurface, of Correlation through Mississippi, Alabama, and Florida. By Donald W. Gravell and Marcus A. Hanna . . . 984
Texas, Active Faulting in Lavaca County. Geological Note by Douglas E. Bell and V. A. Brill . . . 104
———, Cedar Point Field, Chambers County. Geological Note by Joseph M. Wilson . . . 1601
———, Chapel Hill Pool, Smith County. Geological Note by F. H. Lahee. . 1107
———, Custer Formation of. Discussion by Leroy T. Patton . . . 925
———, Early Paleozoic Formations in. By E. H. Sellards. Abstract . . . 1703
———, East, Résumé of Development in, during 1937. By E. A. Wendlandt and C. L. Herold . . . 728
———, Friendswood Field, Harris County. Geological Note by Olin G. Bell . 1602
———, Geologic Cross Section from Fisher County through Andrews County, to Eddy County, New Mexico. By Robert I. Dickey. Abstract . . . 1702
———, Navarro Crossing Field, Houston County. Geological Note by E. B. Wilson . . . 1600
———, North-Central and Central, Geology of. By M. G. Cheney. Abstract . 1703
———, North Cowden Field, Ector County. By Sam C. Giesey and Frank F. Fulk. Abstract . . . 1712
———, Refugio Oil and Gas Field, Refugio County. By Phil F. Martyn . . 1184
———, Sand Hills Area, Western Crane County. By Elliot H. Powers. Abstract . . . 1704
———, South, Activities in, 1937–1938. By Stuart Mossom . . . 750
———, South-North Cross Section from Pecos County through Ector County,

to Roosevelt County, New Mexico. By W. C. Fritz. Abstract 1702
———, South-North Cross Section from Pecos County through Winkler County to Roosevelt County, New Mexico. By E. H. Woods. Abstract 1702
———, Stratigraphy of Eastern Midland Basin. By Lincoln R. Page and John Emery Adams. Abstract 1709
———, Trans-Pecos, Cretaceous and Eocene Stratigraphy of Barrilla and Eastern Davis Mountains of. By C. T. Jones 1423
———, Upper Paleozoic Chinati Series, Presidio County. Geological Note by John W. Skinner 924
———, Upper Paleozoic Section of Chinati Mountains, Presidio County. By John W. Skinner. Abstract 1705
———, Volcanics of the Buck Hill Quadrangle, Brewster County. By Morris A. Elms. Abstract 1712
———, West, Black Shale Basin of; a Preliminary Report. By Taylor Cole. Abstract 1710
———, West, Paleozoic Stratigraphy of the Franklin Mountains of. By L. A. Nelson. Abstract 1704
———, West, Permian Basin, Summary of Regional Geology and Oil Development of. By Ed W. Owen. Abstract 1702
———, West, and Southeast New Mexico, Stratigraphy of Upper and Middle Permian of. By Frank E. Lewis. Abstract 1710
———, West, and Southeastern New Mexico, Developments in, in 1937. By H. P. Bybee, Berte R. Haigh, and Taylor Cole 694
———, Wilcox Eocene Production at Segno Field, Polk County, and Cleveland Field, Liberty County. Geological Note by Marcus A. Hanna 1274
Texas and Louisiana Salt-Dome Cap Rocks, Aragonite in. Geological Note by Marcus A. Hanna and Albert G. Wolf 217
Theory of Reef Barriers. By E. Russell Lloyd. Abstract 1709
Thirty-Year Oil Fields. Editorial by Wallace E. Pratt. The Association Round Table 1698
Thom, Jr., W. T. Bighorn Basin-Yellowstone Valley Structural Field Conference, 1937. Geological Note 306
Thomas, G. D. Carterville-Sarepta and Shongaloo Fields, Bossier and Webster Parishes, Louisiana 1473
Thomas, J. Elmer. Seventeenth International Geological Congress, Moscow, July–August, 1937. The Association Round Table 119
Thomas, Ralph N. Source of "Corniferous" Oil in Eastern Kentucky. Geological Note 1452
Tickell, Frederick G., and Hiatt, William N. Effect of Angularity of Grain on Porosity and Permeability of Unconsolidated Sands. Geological Note . 1272
Tillotson, Allen W. Olympic Pool, Hughes and Okfuskee Counties, Oklahoma . 1579
Time of Accumulation, Criteria for Determining, Under Special Circumstances. By Stanley C. Herold 834
——— of Origin and Accumulation of Petroleum Submitted to Research Committee, Second Annual Report on Study of. By F. M. Van Tuyl and Ben H. Parker 609
Toler, Henry N., and Monroe, Watson H. The Jackson Gas Field and the State Deep Test Well. Abstract 1286
Tolman, C. F. Ground Water. Review by O. E. Meinzer 490
Tomalin, W. G. C. Stratigraphy of Cretaceous Formations in the Neighborhood of the Rio Carache Valley, State of Trujillo. Abstract 1103
Torrance Oil Field, New Development in the Southeastern Extension of. By Richard G. Reese. Abstract 1715
Trans-Pecos Texas, Cretaceous and Eocene Stratigraphy of Barrilla and Eastern Davis Mountains of. By C. T. Jones 1423
Transactions American Geophysical Union, 1937. Review by Donald C. Barton 111
Transcendent Value of Graptolites for Correlation Demonstrated. Geological Note by Charles E. Decker 221
Trask, Parker D. Review of Sediment-Heft (Symposium on Sediments) . . 1692
Trenton and Medina of Western New York. By Chris A. Hartnagel . . . 79
Trinidad, Geology of Soldado Rock between Venezuela and. By H. Kugler. Abstract 1105
———, Notes on Cretaceous of. By A. G. Hutchison. Abstract 1105

Trinity Age, Newly Discovered Section of, in Southwestern New Mexico. By Samuel G. Lasky 524
Trueman, A. E. An Introduction to Geology. Review by John L. Rich . . 1288
Trujillo, State of, Stratigraphy of Cretaceous Formations in the Neighborhood of the Rio Carache Valley. W. G. C. Tomalin 1103
Twenty-Third Annual Meeting, New Orleans, Louisiana, March 16–18, 1938. The Association Round Table 117, 231, 577
Twenty-Fourth Annual Meeting, Oklahoma City, March 22-24, 1939. Announcement. The Association Round Table 1299, 1460, 1700

Umbgrove, J. H. F. Geological History of the East Indies 1
Unconsolidated Sands, Effect of Angularity of Grain on Porosity and Permeability of. Geological Note by Frederick G. Tickell and William N. Hiatt . 1272
Unexposed Silurian Section and Producing Zone of Irvine Oil Field, Estill County, Kentucky. Geological Note by Arthur C. McFarlan 1447
U.S.S.R., Pre-Congress Permian Conference in. Discussion by James Steele Williams 771
United States, East-Central, Stratigraphy and Structural History of. By Norval Ballard 1519
United States Government, First Geologic Work Fostered by. By E. H. Finch . 1250
Untergrund von Schleswig-Holstein nach den Ergebnissen seismischer Refraktionsmesungen (The Subsurface of Schleswig-Holstein in Light of Seismic Refraction Surveys). By H. Reich. Review by Walter Kauenhowen . . . 494
Upper Paleozoic Section of the Chinati Mountains, Presidio County, Texas. By John W. Skinner. Abstract 1705
Utah, Sediments of Great Salt Lake. By A. J. Eardley 1305

Venezuela, Central, Geological Succession of. By M. Kamen Kaye . . 1224, 1605
Venezuelan Andes, Central, the Pre-Cretaceous Rocks of, with Some Remarks about the Tectonics, By E. Kundig. Abstract 1103
Venezuelan Geological Congress, Second, San Cristobal, April 1–7, 1938: Abstracts. Geological Note by H. D. Hedberg 1101
Ver Wiebe, Walter A. Oil and Gas Resources of Western Kansas. Review by N. W. Bass 1287
———. Report of Editor 600
———. Review of The Science of Petroleum 777
Volcanics of the Buck Hill Quadrangle, Brewster County, Texas. By Morris A. Elms. Abstract 1712

Wasson, Theron. Recent Oil Discoveries in Southeastern Illinois 71
Weaver, Paul. Memorial of John Malcolm Muir 509
Webb, Robert W., and Putnam, William C. Laboratory Exercises in Physical Geology. Review by H. W. Straley, III 501
Webster and Bossier Parishes, Louisiana, Carterville-Sarepta and Shongaloo Fields. By G. D. Thomas 1473
Webster Parish, Louisiana, Discovery of Oil in Bodcaw Sand, Cotton Valley Field. Geological Note by A. A. Holston 1603
Weeks, Warren B. South Arkansas Stratigraphy with Emphasis on the Older Coastal Plain Beds 953
Well-Spacing Problem, the Geologist and the. By Edgar Kraus 1440
Wendlandt, E. A., and Herold, C. L. Résumé of Development in East Texas during 1937 728
West Indian Geology, Bibliography of. By L. M. R. Rutten. Review by R. D. Reed 1460
West Montebello Oil Field. By F. M. Ziegler. Abstract 1715
West Texas, Black Shale Basin of; a Preliminary Report. By Taylor Cole. Abstract 1710
———, Paleozoic Stratigraphy of Franklin Mountains of. By L. A. Nelson. Abstract 1704
West Texas and Southeastern New Mexico, Developments in, in 1937. By H. P. Bybee, Berte R. Haigh, and Taylor Cole 694
West Texas Permian Basin, Summary of Regional Geology and Oil Development of. By Ed W. Owen. Abstract 1702

West Virginia, Anticlinal Theory and Later Developments in. By Paul H. Price 1097
———, Early Development of Drilling Practices in Kanawah County. By J. E. Billingsley 1088
———, the Oriskany in. By Robert C. Lafferty 175
Western Interior Region and Gulf Region, Comparison of Upper Cretaceous Deposits of. Lloyd W. Stephenson and John B. Reeside, Jr. 1629
Where Shall Our Young Graduates in Petroleum Geology Acquire Field Experience? By Frederic H. Lahee. The Association Round Table . . . 1613
Wilcox Eocene Production at Segno Field, Polk County, and Cleveland Field, Liberty County, Texas. Geological Note by Marcus A. Hanna . . . 1274
Wildcat Drilling in 1935 and 1936. Corrections 1236
——— in 1937. By Frederic H. Lahee 645
——— in 1937, Further Data on. By Frederic H. Lahee 1231
Wilder, Newell M. Practical Repressuring 189
Wilhelm, Arthur K. Memorial of Lloyd Irvin Yeager 1128
Williams, James Steele. Pre-Congress Permian Conference in the U.S.S.R. Discussion 771
Willis, Robin. New Development at Potrero Oil Field. Abstract 1715
———. Northwestern Extension of Long Beach Oil Field. Abstract . . . 1715
Wilmington Oil Field, Eastern Extension of. By E. J. Bartosh. Abstract . . 1715
———, Los Angeles County, California. By E. J. Bartosh 1048
Wilson, E. B. Navarro Crossing Field, Houston County, Texas. Geological Note 1600
Wilson, George A. Rôle of Petroleum Geologist in Development of Law of Oil and Gas 1080
Wilson, Joseph M. Cedar Point Field, Chambers County, Texas. Geological Note 1601
Wilson, Jr., Charles W. Geology of Muskogee-Porum District, Muskogee and McIntosh Counties, Oklahoma. Review by J. L. Borden 224
———. Revision of Stratigraphy of Dry Creek and Golden Structures, Carbon County, Montana. Geological Note. 106
Wilson, R. M. Proposed New Definition for Linear Units. The Association Round Table 1616
Wolf, Albert G., and Hanna, Marcus A. Aragonite in Texas and Louisiana Salt-Dome Cap Rocks. Geological Note 217
Woods, E. H. South-North Cross Section from Pecos County through Winkler County, Texas, to Roosevelt County, New Mexico. Abstract 1702

Yeager, Lloyd Irvin. Memorial by Arthur K. Wilhelm 1128
Yellowstone Valley-Bighorn Basin Structural Field Conference, 1937. Geological Note by W. T. Thom, Jr. 306

Zavoico, Basil B. Russian Oil Fields in 1937 758
Ziegler, F. M. West Montebello Oil Field. Abstract 1715
Zulia, State of, Venezuela, Notes on the Stratigraphy of the Younger Tertiary Formations of the District of Bolivar. By G. E. Manger. Abstract . . 1103
Zulia-Falcon Basin, Contributions to the Geology of. By C. Gonzalez de Juana. Abstract 1104

BULLETIN
of the
AMERICAN ASSOCIATION OF PETROLEUM GEOLOGISTS

BULLETIN
of the
AMERICAN ASSOCIATION OF PETROLEUM GEOLOGISTS

WALTER A. VER WIEBE, *Editor*
GEOLOGICAL DEPARTMENT, UNIVERSITY OF WICHITA, WICHITA, KANSAS

ASSOCIATE EDITORS

GENERAL	K. C. HEALD, Gulf Oil Corporation, Box 1166, Pittsburgh, Pa.
	HUGH D. MISER, U. S. Geological Survey, Washington, D. C
	THERON WASSON, Room 2308, 35 E. Wacker Drive, Chicago, Ill.
GEOPHYSICS	G. H. WESTBY, Seismograph Service Corporation, Tulsa, Okla.
APPALACHIAN	
North	JOHN R. REEVES, Penn-York Natural Gas Corporation, Buffalo, N.Y.
South	WILLIAM O. ZIEBOLD, 1572 Virginia Street, Charleston, W. Va.
NORTH CENTRAL STATES	R. B. NEWCOMBE, 303 South Main Street, Mount Pleasant, Mich.
KANSAS	ANTHONY FOLGER, Gulf Oil Corporation, Wichita, Kan.
OKLAHOMA	
Western	ROBERT H. DOTT, Oklahoma Geological Survey, Norman, Okla.
Eastern	SHERWOOD BUCKSTAFF, Shell Petroleum Corporation, Tulsa, Okla.
TEXAS	
North and Central	J. B. LOVEJOY, Gulf Oil Corporation, Fort Worth, Tex.
Northeastern	E. A. WENDLANDT, Humble Oil and Refining Company, Tyler, Tex.
Panhandle	JOHN E. GALLEY, Shell Petroleum Corporation, Amarillo, Tex.
San Antonio	HERSCHEL H. COOPER, 1015 Milam Building, San Antonio, Tex.
Permian Basin	HAL P. BYBEE, Box 2101, University Station, Austin, Tex.
GULF COAST	SIDNEY A. JUDSON, Texas Gulf Producing Company, Houston, Tex.
	MARCUS A. HANNA, Gulf Oil Corporation, Houston, Tex.
ARKANSAS AND NORTH LOUISIANA	C. L. MOODY, Ohio Oil Company, Shreveport, La.
ROCKY MOUNTAIN	A. E. BRAINERD, Continental Oil Company, Denver, Colo.
CALIFORNIA	W. S. W. KEW, Standard Oil Company, Los Angeles, Calif.
	W. D. KLEINPELL, Box 1131, Bakersfield, Calif.
FOREIGN	
General	MARGARET C. COBB, Room 2703, 120 Broadway, New York, N. Y.
Europe	W. A. J. M. VAN WATERSCHOOT VAN DER GRACHT, Staatstoezicht op de Mijnen, Heerlen, Holland
Canada	THEODORE A. LINK, Imperial Oil, Ltd., Calgary, Alberta.
South America	HOLLIS D. HEDBERG, Mene Grande Oil Co., Apt. 35, Ciudad Bolivar Venezuela

VOLUME 22

JANUARY—DECEMBER 1938

PART I

PAGES 1-788

ASSOCIATION HEADQUARTERS
BOX 979, TULSA, OKLAHOMA

THE AMERICAN ASSOCIATION OF PETROLEUM GEOLOGISTS, INC.

OFFICERS FOR THE YEAR ENDING MARCH, 1939

DONALD C. BARTON, *President*
Houston, Texas

HAROLD W. HOOTS, *Vice-President*
Los Angeles, California

IRA H. CRAM, *Secretary-Treasurer*
Tulsa, Oklahoma

WALTER A. VER WIEBE, *Editor*
Wichita, Kansas

(The foregoing officers, together with the *Past-President*, H. B. FUQUA, Fort Worth, Texas, constitute the Executive Committee)

DISTRICT REPRESENTATIVES

(Representatives' terms expire immediately after annual meetings of the years shown in parentheses)

Amarillo
Carl C. Anderson (1940), Amarillo, Texas
Appalachian
Robert W. Clark (1939), Pittsburgh, Pa.
Canada
S. E. Slipper (1939), Calgary, Canada
Capital
Arthur A. Baker (1940), Washington, D. C.
Dallas
P. W. McFarland (1940), Dallas, Texas
East Oklahoma
Frederic A. Bush (1939), Tulsa, Okla.
R. B. Rutledge (1939), Tulsa, Okla.
W. B. Wilson (1940), Tulsa, Okla.
Fort Worth
Charles E. Yager (1939), Fort Worth, Texas
Great Lakes
Benjamin F. Hake (1939), Saginaw, Mich.
Houston
Orval L. Brace (1939), Houston, Texas
David Perry Olcott (1939), Houston, Texas
Wallace C. Thompson (1940), Houston, Texas
Mexico
William A. Baker (1939), Tampico, Mexico
New Mexico
Harold S. Cave (1939), Roswell, New Mexico
New York
W. T. Thom, Jr. (1939), Princeton, N. J.
Pacific Coast
A. Arthur Curtice (1939), Los Angeles, Calif.
Homer J. Steiny (1939), Los Angeles, Calif.
E. J. Bartosh (1940), Los Angeles, Calif.
Rocky Mountains
J. Harlan Johnson (1939), Golden, Colo.
Shreveport
A. F. Crider (1939), Shreveport, La.
South America
James A. Tong (1939), Caracas, Venezuela S.A.
So. Permian Basin
Cary P. Butcher (1939), Midland, Texas
South Texas
Fred P. Shayes (1939), Beeville, Texas
R. F. Schoolfield (1939), San Antonio, Texas
Tyler
A. C. Wright (1939), Tyler, Texas
West Oklahoma
V. G. Hill (1939), Shawnee, Okla.
Wichita
Edward A. Koester (1939), Wichita, Kan.
Wichita Falls
Virgil Pettigrew (1940), Wichita Falls, Texas

DIVISION REPRESENTATIVES

Paleontology and Mineralogy

E. H. Sellards (1939), Austin, Texas

Henry V. Howe (1939), Baton Rouge, La.

OFFICERS FOR THE YEAR ENDING MARCH, 1938

President: H. B. FUQUA

Vice-President: C. L. MOODY

Secretary-Treasurer: IRA H. CRAM

Editor: WALTER A. VER WIEBE

(The foregoing officers, together with the *Past-President*, RALPH D. REED, Los Angeles, California, constitute the Executive Committee)

COPYRIGHT 1938 BY
THE AMERICAN ASSOCIATION OF
PETROLEUM GEOLOGISTS

PUBLISHED
MONTHLY

Composed and Printed by
George Banta Publishing Company
Menasha, Wisconsin, U.S.A.

CONTENTS OF VOLUME 22

PART I

NUMBER 1

GEOLOGICAL HISTORY OF THE EAST INDIES. J. H. F. UMBGROVE . . . 1
RECENT OIL DISCOVERIES IN SOUTHEASTERN ILLINOIS. Theron Wasson 71
MEDINA AND TRENTON OF WESTERN NEW YORK. Chris A. Hartnagel 79
GEOLOGICAL NOTES
Eleventh Annual Field Conference, Kansas Geological Society, September 2–6, 1937, *Joseph L. Borden* 100
New Interpretation of Monongahela-Dunkard Contact, Washington County, Ohio, *John C. Frye* 103
Active Faulting in Lavaca County, Texas, *Douglas E. Bell* and *V. A. Brill* 104
Revision of Stratigraphy of Dry Creek and Golden Structures, Carbon County, Montana, *Charles W. Wilson, Jr.* 106
DISCUSSION
Discovery Rates in Oil Finding, *F. F. Campbell* 109
REVIEWS AND NEW PUBLICATIONS 111
THE ASSOCIATION ROUND TABLE 116
AT HOME AND ABROAD 124

NUMBER 2

MISSISSIPPIAN GAS SANDS OF CENTRAL MICHIGAN AREA. Edward W. Hard 129
THE ORISKANY IN WEST VIRGINIA. Robert C. Lafferty 175
PRACTICAL REPRESSURING. Newell M. Wilder 189
SEDIMENTS OF SANTA MONICA BAY, CALIFORNIA. F. P. Shepard and G. A. Macdonald 201
GEOLOGICAL NOTES
Aragonite in Texas and Louisiana Salt-Dome Cap Rocks, *Marcus A. Hanna* and *Albert G. Wolf* 217
Transcendent Value of Graptolites for Correlation Demonstrated, *Charles E. Decker* 221
REVIEWS AND NEW PUBLICATIONS 222
THE ASSOCIATION ROUND TABLE 229
AT HOME AND ABROAD 238

NUMBER 3

ORISKANY AS A SOURCE OF GAS AND OIL IN PENNSYLVANIA AND ADJACENT AREAS. Charles R. Fettke 241
CHESTER ROCKS OF MEADE, HARDIN, AND BRECKENRIDGE COUNTIES, KENTUCKY. Ralph E. Stouder 267
GEOLOGY OF TEPETATE OIL FIELD, ACADIA PARISH, LOUISIANA. Max Bornhauser and Fred W. Bates 285

GEOLOGICAL NOTES
Bighorn Basin-Yellowstone Valley Structural Field Conference, 1937, *W. T. Thom, Jr.* 306
Correlation of Cockfield and Gosport Formations, Eastern Mississippi and Western Alabama, *B. W. Blanpied* and *Roy T. Hazzard* 309
REVIEWS AND NEW PUBLICATIONS 315
THE ASSOCIATION ROUND TABLE 326
AT HOME AND ABROAD 385

NUMBER 4

GEOLOGIC OCCURRENCE OF OIL AND GAS IN MICHIGAN. B. F. Hake 393
HISTORY OF DEVELOPMENT AND GEOLOGIC RELATIONSHIPS OF APPALACHIAN FIELDS. George H. Ashley 416
BIBLIOGRAPHY OF GEOLOGIC STRUCTURE MAPS AND CROSS SECTIONS OF AREAS IN OIL AND GAS STATES EAST OF THE MISSISSIPPI RIVER, AND SOME PRODUCING STATES IN THE MID-CONTINENT REGION. Olive C. Postley 431
GRAPHIC TREATMENT OF FOLDS IN THREE DIMENSIONS. A. J. Eardley 483
REVIEWS AND NEW PUBLICATIONS 490
THE ASSOCIATION ROUND TABLE 507
MEMORIAL
John Malcolm Muir, *Paul Weaver* 509
Arthur W. Duston, *Louis Roark* 511
AT HOME AND ABROAD 513

NUMBER 5

FUTURE OF THE GEOLOGIST IN THE PETROLEUM INDUSTRY. H. B. Fuqua 517
NEWLY DISCOVERED SECTION OF TRINITY AGE IN SOUTHWESTERN NEW MEXICO. Samuel G. Lasky 524
CONDITIONS OF SEDIMENTATION AND SOURCES OF THE ORISKANY SANDSTONE AS INDICATED BY PETROLOGY. Marcellus H. Stow . . 541
GEOLOGICAL LIMITATIONS TO OIL LAW. William W. Porter, II . . . 565
REVIEWS AND NEW PUBLICATIONS 574
THE ASSOCIATION ROUND TABLE 576
MEMORIAL
Dale Darrel Dolsun Sparks, *Cevat Eyup Tasman* 627
AT HOME AND ABROAD 628

NUMBER 6

ECONOMIC ASPECTS OF DRILLING. Joseph E. Pogue 633
WILDCAT DRILLING IN 1937. Frederic H. Lahee 645
RECENT PETROLEUM DEVELOPMENT IN ILLINOIS. Alfred H. Bell and George V. Cohee 649
RECENT DEVELOPMENTS IN MICHIGAN BASIN. E. A. Newman . . . 659
DEVELOPMENTS IN KANSAS, 1937. Rycroft G. Moss 666

DEVELOPMENTS IN ROCKY MOUNTAIN REGION IN 1937. Edwin H. Hunt 677
DEVELOPMENTS IN WEST TEXAS AND SOUTHEASTERN NEW MEXICO IN 1937. H. P. Bybee, Berte R. Haigh and Taylor Cole . . . 694
DISCOVERIES AND ADDITIONS TO OIL RESERVES IN CALIFORNIA DURING 1937. Harold W. Hoots 701
DEVELOPMENTS IN SOUTH ARKANSAS AND NORTH LOUISIANA IN 1937. H. K. Shearer 719
RÉSUMÉ OF DEVELOPMENT IN EAST TEXAS DURING 1937. E. A. Wendlandt and C. L. Herold 728
GULF COASTAL DEVELOPMENTS IN 1937. O. L. Brace 736
ACTIVITIES IN SOUTH TEXAS, 1937–1938. Stuart Mossom 750
RUSSIAN OIL FIELDS IN 1937. Basil B. Zavoico 758
GEOLOGICAL NOTES
Use of Stratigraphic Names, *John G. Bartram* 763
Cores from a Deep Well at Rodessa, Caddo Parish, Louisiana, *M. C. Israelsky* 764
DISCUSSION
Pre-Congress Permian Conference in the U.S.S.R., *James Steele Williams* 771
REVIEWS AND NEW PUBLICATIONS 777
THE ASSOCIATION ROUND TABLE 781
AT HOME AND ABROAD 784

ERRATA

Page 436, line 9 under heading CENTRAL: "A. F. Hoffman" should be *A. D. Hoffman.*

Page 734, line 3 from end of page of text: "Robertson No. 1 (*8*)" should be *Robertson No. 1* (*7*).

BULLETIN
of the
AMERICAN ASSOCIATION OF PETROLEUM GEOLOGISTS

BULLETIN
of the
AMERICAN ASSOCIATION OF PETROLEUM GEOLOGISTS

WALTER A. VER WIEBE, *Editor*
GEOLOGICAL DEPARTMENT, UNIVERSITY OF WICHITA, WICHITA, KANSAS

ASSOCIATE EDITORS

GENERAL	K. C. HEALD, Gulf Oil Corporation, Box 1166, Pittsburgh, Pa.
	HUGH D. MISER, U. S. Geological Survey, Washington, D. C.
	THERON WASSON, Room 2308, 35 E. Wacker Drive, Chicago, Ill.
GEOPHYSICS	G. H. WESTBY, Seismograph Service Corporation, Tulsa, Okla.
APPALACHIAN	
North	JOHN R. REEVES, Penn-York Natural Gas Corporation, Buffalo, N. Y.
South	WILLIAM O. ZIEBOLD, 1572 Virginia Street, Charleston, W. Va.
NORTH CENTRAL STATES	R. B. NEWCOMBE, 303 South Main Street, Mount Pleasant, Mich.
KANSAS	ANTHONY FOLGER, Gulf Oil Corporation, Wichita, Kan.
OKLAHOMA	
Western	ROBERT H. DOTT, Oklahoma Geological Survey, Norman, Okla.
Eastern	SHERWOOD BUCKSTAFF, Shell Petroleum Corporation, Tulsa, Okla
TEXAS	
North and Central	J. B. LOVEJOY, Gulf Oil Corporation, Fort Worth, Tex.
Northeastern	E. A. WENDLANDT, Humble Oil and Refining Company, Tyler, Tex.
Panhandle	JOHN E. GALLEY, Shell Petroleum Corporation, Amarillo, Tex.
San Antonio	HERSCHEL H. COOPER, 1015 Milam Building, San Antonio, Tex.
Permian Basin	HAL P. BYBEE, Box 2101, University Station, Austin, Tex.
GULF COAST	SIDNEY A. JUDSON, Texas Gulf Producing Company, Houston, Tex.
	MARCUS A. HANNA, Gulf Oil Corporation, Houston, Tex.
ARKANSAS AND NORTH LOUISIANA	C. L. MOODY, Ohio Oil Company, Shreveport, La.
ROCKY MOUNTAIN	A. E. BRAINERD, Continental Oil Company, Denver, Colo.
CALIFORNIA	W. S. W. KEW, Standard Oil Company, Los Angeles, Calif.
	W. D. KLEINPELL, Box 1131, Bakersfield, Calif.
FOREIGN	
General	MARGARET C. COBB, Room 2703, 120 Broadway, New York, N. Y.
Europe	W. A. J. M. VAN WATERSCHOOT VAN DER GRACHT, Staatstoezicht op de Mijnen, Heerlen, Holland
Canada	THEODORE A. LINK, Imperial Oil, Ltd., Calgary, Alberta.
South America	HOLLIS D. HEDBERG, Mene Grande Oil Co , Apt. 35, Ciudad Bolivar Venezuela

VOLUME 22
JANUARY—DECEMBER 1938

PART II

PAGES 789-1746

ASSOCIATION HEADQUARTERS
BOX 979, TULSA, OKLAHOMA

THE AMERICAN ASSOCIATION OF PETROLEUM GEOLOGISTS, INC.

OFFICERS FOR THE YEAR ENDING MARCH, 1939

DONALD C. BARTON, *President*
Houston, Texas

HAROLD W. HOOTS, *Vice-President*
Los Angeles, California

IRA H. CRAM, *Secretary-Treasurer*
Tulsa, Oklahoma

WALTER A. VER WIEBE, *Editor*
Wichita, Kansas

(The foregoing officers, together with the *Past-President*, H. B. FUQUA, Fort Worth, Texas, constitute the Executive Committee)

DISTRICT REPRESENTATIVES

(Representatives' terms expire immediately after annual meetings of the years shown in parentheses)

Amarillo
Carl C. Anderson (1940), Amarillo, Texas
Appalachian
Robert W. Clark (1939), Pittsburgh, Pa.
Canada
S. E. Slipper (1939), Calgary, Canada
Capital
Arthur A. Baker (1940), Washington, D. C.
Dallas
P. W. McFarland (1940), Dallas, Texas
East Oklahoma
Frederic A. Bush (1939), Tulsa, Okla.
R. B. Rutledge (1939), Tulsa, Okla.
W. B. Wilson (1940), Tulsa, Okla.
Fort Worth
Charles E. Yager (1939), Fort Worth, Texas
Great Lakes
Benjamin F. Hake (1939), Saginaw, Mich.
Houston
Orval L. Brace (1939), Houston, Texas
David Perry Olcott (1939), Houston, Texas
Wallace C. Thompson (1940), Houston, Texas
Mexico
William A. Baker (1939), Tampico, Mexico
New Mexico
Harold S. Cave (1939), Roswell, New Mexico
New York
W. T. Thom, Jr. (1939), Princeton, N. J.
Pacific Coast
A. Arthur Curtice (1939), Los Angeles, Calif.
Homer J. Steiny (1939), Los Angeles, Calif.
E. J. Bartosh (1940), Los Angeles, Calif.
Rocky Mountains
J. Harlan Johnson (1939), Golden, Colo.
Shreveport
A. F. Crider (1939), Shreveport, La.
South America
James A. Tong (1939), Caracas, Venezuela, S.A.
So. Permian Basin
Cary P. Butcher (1939), Midland, Texas
South Texas
Fred P. Shayes (1939), Beeville, Texas
R. F. Schoolfield (1939), San Antonio, Texas
Tyler
A. C. Wright (1939), Tyler, Texas
West Oklahoma
V. G. Hill (1939), Shawnee, Okla.
Wichita
Edward A. Koester (1939), Wichita, Kan.
Wichita Falls
Virgil Pettigrew (1940), Wichita Falls, Texas

DIVISION REPRESENTATIVES

Paleontology and Mineralogy

E. H. Sellards (1939), Austin, Texas

Henry V. Howe (1939), Baton Rouge, La.

OFFICERS FOR THE YEAR ENDING MARCH, 1938

President: H. B. FUQUA

Vice-President: C. L. MOODY

Secretary-Treasurer: IRA H. CRAM

Editor: WALTER A. VER WIEBE

(The foregoing officers, together with the *Past-President*, RALPH D. REED, Los Angeles, California, constitute the Executive Committee)

COPYRIGHT 1938 BY
THE AMERICAN ASSOCIATION OF
PETROLEUM GEOLOGISTS

PUBLISHED
MONTHLY

Composed and Printed by
George Banta Publishing Company
Menasha, Wisconsin, U.S.A.

CONTENTS OF VOLUME 22

PART II

NUMBER 7

STRATIGRAPHY OF COASTAL PLAIN OF GEORGIA. C. Wythe Cooke and Arthur C. Munyan 789

RECENT PETROLEUM ACTIVITIES IN COASTAL PLAIN OF SOUTH GEORGIA. A. C. Munyan 794

OIL AND GAS POSSIBILITIES IN ATLANTIC COASTAL PLAIN FROM NEW JERSEY TO FLORIDA. Olive C. Postley 799

SCANLAN, OR MIDWAY, DOME, LAMAR COUNTY, MISSISSIPPI. D. J. Munroe 816

APPLICATION OF PRINCIPLE OF DIFFERENTIAL SETTLING TO TRACING OF LENTICULAR SAND BODIES. John L. Rich 823

CRITERIA FOR DETERMINING THE TIME OF ACCUMULATION UNDER SPECIAL CIRCUMSTANCES. Stanley C. Herold 834

STRATIGRAPHY OF THE BENDIAN OF THE OKLAHOMA SALIENT OF THE OUACHITA MOUNTAINS. Bruce H. Harlton 852

GEOLOGICAL NOTES

Possible Nature of Limestone Reservoirs in the Permian Basin, *H. P. Bybee* 915

Subsurface Study of Cherokee Formation Near Kansas City, Missouri, *Glenn G. Bartle* 918

Upper Paleozoic Chinati Series, Presidio County, Texas, *John W. Skinner* 924

DISCUSSION

Custer Formation of Texas, *Leroy T. Patton* 925

Deepest Rocks at Jackson, Mississippi, *Watson H. Monroe* . 927

REVIEWS AND NEW PUBLICATIONS 929

THE ASSOCIATION ROUND TABLE 940

AT HOME AND ABROAD 946

NUMBER 8

SOUTH ARKANSAS STRATIGRAPHY WITH EMPHASIS ON THE OLDER COASTAL PLAIN BEDS. Warren B. Weeks. 953

SUBSURFACE TERTIARY ZONES OF CORRELATION THROUGH MISSISSIPPI, ALABAMA, AND FLORIDA. Donald W. Gravell and Marcus A. Hanna. 984

COMPARISON OF PERMIAN AMMONOID ZONES OF SOVIET RUSSIA WITH THOSE OF NORTH AMERICA. A. K. Miller 1014

PETROLEUM AND NATURAL GAS IN NON-MARINE SEDIMENTS OF POWDER WASH FIELD IN NORTHWEST COLORADO. W. T. Nightingale 1020

WILMINGTON OIL FIELD, LOS ANGELES COUNTY, CALIFORNIA. E. J. Bartosh 1048

RÔLE OF PETROLEUM GEOLOGIST IN DEVELOPMENT OF LAW OF OIL AND GAS. George A. Wilson 1080

EARLY DEVELOPMENT OF DRILLING PRACTICES IN KANAWHA COUNTY, WEST VIRGINIA. J. E. Billingsley 1088
ANTICLINAL THEORY AND LATER DEVELOPMENTS IN WEST VIRGINIA. Paul H. Price 1097
GEOLOGICAL NOTES
Second Venezuelan Geological Congress, San Cristobal, April 1–7, 1938: Abstracts, *H. D. Hedberg* 1101
Deep Well near Marlow, Stephens County, Oklahoma, *E. A. Paschal*. 1106
Chapel Hill Pool, Smith County, Texas, *F. H. Lahee* . . . 1107
DISCUSSION
Conditions of Sedimentation and Sources of the Oriskany Sandstone as Indicated by Petrology, by Marcellus H. Stow, *Arthur B. Cleaves* 1108
REVIEWS AND NEW PUBLICATIONS 1112
THE ASSOCIATION ROUND TABLE 1117
MEMORIAL
Ivan Vincent Bentz, *L. B. Snider* 1127
Lloyd Irvin Yeager, *Arthur K. Wilhelm* 1128
AT HOME AND ABROAD 1129

NUMBER 9

ORIGIN OF MCMURRAY OIL SANDS, ALBERTA. J. C. Sproule . . . 1133
REGIONAL VARIATIONS IN COMPOSITION OF NATURAL GAS IN APPALACHIAN PROVINCE. Paul H. Price and A. J. W. Headlee . . 1153
GEOLOGY OF REFUGIO OIL AND GAS FIELD, REFUGIO COUNTY, TEXAS. Phil F. Martyn 1184
ORIGIN OF RED SEA DEPRESSION. L. Owen 1217
GEOLOGICAL SUCCESSION OF CENTRAL VENEZUELA. M. Kamen Kaye 1224
FURTHER DATA ON WILDCAT DRILLING IN 1937. Frederic H. Lahee 1231
CORRECTIONS IN ARTICLE ON "WILDCAT DRILLING IN 1935 AND 1936," PUBLISHED IN THE BULLETIN, PAGES 1079–1082, AUGUST, 1937. Frederic H. Lahee 1236
BEHAVIOR OF FLUIDS IN OIL RESERVOIRS. T. V. Moore 1237
FIRST GEOLOGIC WORK FOSTERED BY UNITED STATES GOVERNMENT. E. H. Finch 1250
PROBLEM OF SECONDARY TILT—HARKER'S SOLUTION CORRECTED. Edmund M. Spieker 1255
PROBLEM OF TWO TILTS AND STEREOGRAPHIC PROJECTION. L. Jerome Fisher 1261
GEOLOGICAL NOTES
Effect of Angularity of Grain on Porosity and Permeability of Unconsolidated Sands, *Frederick G. Tickell* and *William N. Hiatt* 1272
Wilcox Eocene Production at Segno Field, Polk County, and Cleveland Field, Liberty County, Texas, *Marcus A. Hanna* 1274
Shreveport Field, Caddo Parish, Louisiana, *M. W. Grimm* . 1277
Microscope Eclipse Plate for Routine Index Determinations, *Walter B. Lang* 1278

DISCUSSION
Naming Subsurface Formations, *Ronald K. DeFord* 1280
REVIEWS AND NEW PUBLICATIONS 1282
THE ASSOCIATION ROUND TABLE 1292
AT HOME AND ABROAD 1302

NUMBER 10

SEDIMENTS OF GREAT SALT LAKE, UTAH. A. J. Eardley 1305
DARROW SALT DOME, ASCENSION PARISH, LOUISIANA. Carroll E. Cook 1412
CRETACEOUS AND EOCENE STRATIGRAPHY OF BARRILLA AND EASTERN DAVIS MOUNTAINS OF TRANS-PECOS TEXAS. C. T. Jones . . 1423
THE GEOLOGIST AND THE WELL-SPACING PROBLEM. Edgar Kraus . . 1440
GEOLOGICAL NOTES
Unexposed Silurian Section and Producing Zone of Irvine Oil Field, Estill County, Kentucky, *Arthur C. McFarlan* . . 1447
Source of "Corniferous" Oil in Eastern Kentucky, *Ralph N. Thomas* 1452
REVIEWS AND NEW PUBLICATIONS 1457
THE ASSOCIATION ROUND TABLE 1466
AT HOME AND ABROAD 1469

NUMBER 11

CARTERVILLE-SAREPTA AND SHONGALOO FIELDS, BOSSIER AND WEBSTER PARISHES, LOUISIANA. G. D. Thomas 1473
SUGAR CREEK FIELD, CLAIBORNE PARISH, LOUISIANA. C. C. Clark 1504
STRATIGRAPHY AND STRUCTURAL HISTORY OF EAST-CENTRAL UNITED STATES. Norval Ballard 1519
JESSE POOL, PONTOTOC AND COAL COUNTIES, OKLAHOMA. W. Baxter Boyd 1560
OLYMPIC POOL, HUGHES AND OKFUSKEE COUNTIES, OKLAHOMA. Allen W. Tillotson 1579
RESIDUES FROM "MISSISSIPPI LIME" OF CENTRAL KANSAS. T. C. Hiestand 1588
GEOLOGICAL NOTES
Navarro Crossing Field, Houston County, Texas, *E. B. Wilson* 1600
Cedar Point Field, Chambers County, Texas, *Joseph M. Wilson* 1601
Friendswood Field, Harris County, Texas, *Olin G. Bell* . . 1602
Discovery of Oil in Bodcaw Sand, Cotton Valley Field, Webster Parish, Louisiana, *A. A. Holston* 1603
DISCUSSION
Powder Wash Field, Colorado, Water Analysis, *L. C. Case* and *W. T. Nightingale* 1604
REVIEWS AND NEW PUBLICATIONS 1606
THE ASSOCIATION ROUND TABLE 1613
MEMORIAL
Clyde M. Becker, *L. J. Fulton* 1621
AT HOME AND ABROAD 1623

NUMBER 12

COMPARISON OF UPPER CRETACEOUS DEPOSITS OF GULF REGION AND WESTERN INTERIOR REGION. Lloyd W. Stephenson and John B. Reeside, Jr. 1629
STRATIGRAPHY OF UPPER CRETACEOUS SERIES IN MISSISSIPPI AND ALABAMA. Lloyd W. Stephenson and W. H. Monroe . . . 1639
BELLEVUE OIL FIELD, BOSSIER PARISH, LOUISIANA. A. F. Crider . . 1658
RELATION OF ROUGH CREEK FAULT OF KENTUCKY TO THE OUACHITA DEFORMATION. William L. Russell 1682
GEOLOGICAL NOTES
An Historical Document of Interest to Petroleum Geologists, *Wilber Stout* 1687
REVIEWS AND NEW PUBLICATIONS 1692
THE ASSOCIATION ROUND TABLE 1698
AT HOME AND ABROAD 1720
INDEX OF VOLUME 22 1723

ERRATA

Page 897, 3rd new paragraph, line 3: "Fig. 19" should be *Fig. 18.*

Page 897, last paragraph, line 13: "Fig. 18" should be *Fig. 19.*

Page 1038, water analysis, *Sample IV:* the following carbonate values should be inserted.

	(CO_3)
Parts per million	284
Reacting value	9.43
Value in percentage	1.68

after Primary alkalinity, "17.48%" should be *0.00%*
after Secondary alkalinity, "0.00%" should be *4.00%*
after Chloride salinity, "97.52%" should be *98.95%*

Page 1225, line 2 from end: "southwest" should be *southeast.*

PROFESSIONAL DIRECTORY

Space for Professional Cards Is Reserved for Members of the Association. For Rates Apply to A.A.P.G. Headquarters, Box 979, Tulsa, Oklahoma

CALIFORNIA

WILLARD J. CLASSEN
Consulting Geologist
Petroleum Engineer
1093 Mills Building
SAN FRANCISCO, CALIFORNIA

RICHARD R. CRANDALL
Consulting Geologist
404 Haas Building
LOS ANGELES, CALIFORNIA

J. E. EATON
Consulting Geologist
2062 N. Sycamore Avenue
LOS ANGELES, CALIFORNIA

PAUL P. GOUDKOFF
Geologist
Geologic Correlation by Foraminifera and Mineral Grains
799 Subway Terminal Building
LOS ANGELES, CALIFORNIA

WALTER STALDER
Petroleum Geologist
925 Crocker Building
SAN FRANCISCO, CALIFORNIA

VERNON L. KING
Petroleum Geologist and Engineer
1227 Bank of America Building
LOS ANGELES, CALIFORNIA

R. W. SHERMAN
Consulting Geologist
Pacific Mutual Building
523 West Sixth St.
LOS ANGELES

CALIFORNIA

R. L. TRIPLETT
Contract Core Drilling

WHitney 9876 — 2013 West View St. Los ANGELES, CALIF.

CHAS. GILL MORGAN
United Geophysical Company
Pasadena — California

COLORADO

HEILAND RESEARCH CORPORATION
Registered Geophysical Engineers
— *Instruments* —
— Surveys — Interpretations —
C. A. HEILAND, *President* — Club Bldg. DENVER, COLO.

CUBA

R. H. PALMER
Petroleum Geologist
Examinations and Reports on Cuban Oil Lands
Neptuno 1060 — HABANA, CUBA

KANSAS

MARVIN LEE
Consulting Petroleum Geologist
1109 Bitting Building
WICHITA, KANSAS
Office: 3-8941 — *Residence:* 4-4873
GEOLOGY AND PRODUCTION PROBLEMS OF OIL AND GAS IN THE UNITED STATES
Formerly Technical Adviser to State Corporation Commission. Official mail should be addressed to the Commission.

L. C. MORGAN
Petroleum Engineer and Geologist
Specializing in Acid-Treating Problems
358 North Dellrose
WICHITA, KANSAS

LOUISIANA

WILLIAM M. BARRET, INC.
Consulting Geophysicists
Specializing in Magnetic Surveys
Giddens-Lane Building — SHREVEPORT, LA.

HOLL AND OBORNE
Consulting Geologists
F. G. HOLL, 4121 East English, Wichita, Kansas
HARRY W. OBORNE, 1328 North Tejon St., Colorado Springs, Colo.

MICHIGAN

WILLIAM F. BROWN
Consulting Geologist
BOX 302 — MOUNT PLEASANT, MICH.

NEW MEXICO

RONALD K. DEFORD
Geologist
ROSWELL, NEW MEXICO — MIDLAND, TEXAS

NEW YORK

FREDERICK G. CLAPP
Consulting Geologist
50 Church Street
NEW YORK

BROKAW, DIXON & McKEE
Geologists *Engineers*
OIL—NATURAL GAS
Examinations, Reports, Appraisals
Estimates of Reserves
120 Broadway, New York
Gulf Building, Houston

A. H. GARNER
Geologist *Engineer*
PETROLEUM
NATURAL GAS
120 Broadway New York, N.Y.

OHIO

JOHN L. RICH
Geologist
Specializing in extension of "shoestring" pools
University of Cincinnati
Cincinnati, Ohio

OKLAHOMA

ELFRED BECK
Geologist
525 National Bank of Tulsa Building
TULSA OKLAHOMA

GINTER LABORATORY
CORE ANALYSES
Permeability
Porosity
Reserves
R. L. GINTER
Owner
118 West Cameron, Tulsa

MALVIN G. HOFFMAN
Geologist
Midco Oil Corporation
Midco Building
TULSA, OKLAHOMA

R. W. Laughlin L. D. Simmons
WELL ELEVATIONS
Oklahoma, Kansas, Texas, and
New Mexico
LAUGHLIN-SIMMONS & CO.
605 Oklahoma Gas Building
TULSA OKLAHOMA

MID-CONTINENT TORSION BALANCE SURVEYS
SEISMIC AND GRAVITY INTERPRETATIONS
KLAUS EXPLORATION COMPANY
H. KLAUS
Geologist and Geophysicist
Broadway Tower, Enid, Okla.
Benson Building, Lubbock, Texas

A. I. LEVORSEN
Petroleum Geologist
221 Woodward Boulevard
TULSA OKLAHOMA

OKLAHOMA

GEO. C. MATSON
Geologist
Philcade Building — TULSA, OKLA.

G. H. WESTBY
Geologist and Geophysicist
Seismograph Service Corporation
Kennedy Building — Tulsa, Oklahoma

U. R. LAVES
(BILL LAVES)
Geologist
Pipe setting—Sample determination—Reports
723 S. Broadway — ADA, OKLAHOMA

PENNSYLVANIA

HUNTLEY & HUNTLEY
Petroleum Geologists and Engineers
L. G. HUNTLEY
J. R. WYLIE, JR.
Grant Building, Pittsburgh, Pa.

TEXAS

JOSEPH L. ADLER
Geologist and Geophysicist
Consultant and Contractor in Geological and Geophysical Exploration
325 Esperson Bldg.
HOUSTON, TEXAS

MID-CONTINENT TORSION BALANCE SURVEYS
SEISMIC AND GRAVITY INTERPRETATIONS
KLAUS EXPLORATION COMPANY
H. KLAUS
Geologist and Geophysicist
Broadway Tower, Enid, Okla. — Benson Building, Lubbock, Texas

DONALD C. BARTON
Geologist and Geophysicist
Humble Oil and Refining Company
HOUSTON — TEXAS

D'ARCY M. CASHIN
Geologist — *Engineer*
Specialist, Gulf Coast Salt Domes
Examinations, Reports, Appraisals
Estimates of Reserves
705 Nat'l. Standard Bldg.
HOUSTON, TEXAS

E. DEGOLYER
Geologist
Esperson Building
Houston, Texas
Continental Building
Dallas, Texas

ALEXANDER DEUSSEN
Consulting Geologist
Specialist, Gulf Coast Salt Domes
1006 Shell Building
HOUSTON, TEXAS

DAVID DONOGHUE
Consulting Geologist
Appraisals - Evidence - Statistics
Forth Worth National Bank Building — FORT WORTH, TEXAS

F. B. Porter, *President* — R. H. Fash, *Vice-President*
THE FORT WORTH LABORATORIES
Analyses of Brines, Gas, Minerals, Oil, Interpretation of Water Analyses. Field Gas Testing.
828½ Monroe Street — FORT WORTH, TEXAS
Long Distance 138

TEXAS

J. S. HUDNALL G. W. PIRTLE

HUDNALL & PIRTLE

Petroleum Geologists

Appraisals Reports

Peoples Nat'l. Bank Bldg. TYLER, TEXAS

JOHN S. IVY

Geologist

921 Rusk Building, HOUSTON, TEXAS

W. P. JENNY

Geologist and Geophysicist

Gravimetric Seismic
Magnetic Electric

Surveys and Interpretations

907 Sterling Bldg. HOUSTON, TEXAS

GEO. C. McGHEE

Geologist and Geophysicist

NATIONAL GEOPHYSICAL COMPANY

Tower Petroleum Building

DALLAS, TEXAS

DABNEY E. PETTY

315 Sixth Street

SAN ANTONIO, TEXAS

No Commercial Work Undertaken

E. E. ROSAIRE

SUBTERREX

BY

Geophysics and Geochemistry

Esperson Building Houston, Texas

A. T. SCHWENNESEN

Geologist

1517 Shell Building

HOUSTON TEXAS

ROBERT H. DURWARD

Geologist

Specializing in use of the magnetometer and its interpretations

1431 W. Rosewood Ave. San Antonio, Texas

W. G. SAVILLE J. P. SCHUMACHER A. C. PAGAN

TORSION BALANCE EXPLORATION CO.

Torsion Balance Surveys

1404-10 Shell Bldg. Phone: Capitol 1341
HOUSTON TEXAS

HAROLD VANCE

Petroleum Engineer

Petroleum Engineering Department
A. & M. College of Texas
COLLEGE STATION, TEXAS

CUMMINS & BERGER

Consultants

Specializing in Valuations
Texas & New Mexico

1601-3 Trinity Bldg. Ralph H. Cummins
Fort Worth, Texas Walter R. Berger

WM. C. McGLOTHLIN

Petroleum Geologist and Engineer

Examinations, Reports, Appraisals
Estimates of Reserves

Geophysical Explorations

806 State Nat'l. Bank Bldg., CORSICANA, TEXAS

DIRECTORY OF GEOLOGICAL AND GEOPHYSICAL SOCIETIES

For Space Apply to A.A.P.G. Headquarters
Box 979, Tulsa, Oklahoma

COLORADO

ROCKY MOUNTAIN ASSOCIATION OF PETROLEUM GEOLOGISTS
DENVER, COLORADO

President - - - - - Charles S. Lavington
Continental Oil Company
1st Vice-President - - Warren O. Thompson
985 Gilbert Street, Boulder
2nd Vice-President - - - David B. Miller
1336 Gaylord Street
Secretary-Treasurer - - - - - - Ninetta Davis
224 U. S. Customs Building

Dinner meetings, first and third Mondays of each month, 6:15 P.M., Auditorium Hotel.

KANSAS

KANSAS GEOLOGICAL SOCIETY
WICHITA, KANSAS

President - - - - - - - Edward A. Koester
Darby Petroleum Corporation
Vice-President - - - - Glen C. Woolley
Transwestern Oil Company
Secretary-Treasurer - - Forrest E. Wimbish
517 North Chautauqua
Member of Board - - - - - George H. Norton
Atlantic Refining Company

Regular Meetings: 7:30 P.M., Allis Hotel, first Tuesday of each month. Visitors cordially welcomed.
The Society sponsors the Kansas Well Log Bureau which is located at 412 Union National Bank Building.

LOUISIANA

THE SHREVEPORT GEOLOGICAL SOCIETY
SHREVEPORT, LOUISIANA

President - - - - - - - - - - C. C. Clark
Union Producing Company
Vice-President - - - - - - - L. S. Harlowe
Grogan Oil Company
Secretary-Treasurer - - - - - - E. F. Miller
Oliphant Oil Company, 927 Commercial Bldg.

Meets the first Friday of every month, 7:30 P.M., Civil Courts Room, Caddo Parish Court House. Special dinner meetings by announcement.

SOUTH LOUISIANA GEOLOGICAL SOCIETY
LAKE CHARLES, LOUISIANA

President - - - - - - - - - J. F. Mahoney
Union Sulphur Co., Sulphur Mines, La.
Vice-President - - - - - - - Dean F. Metts
Humble Oil & Refining Co., Crowley, La.
Secretary - - - - - - - - W. R. Canada
Stanolind Oil and Gas Company
Treasurer - - - - - - - - Baker Hoskins
Shell Petroleum Corporation

Meetings: First Monday at noon (12:00) and third Monday at 7:00 P.M. at Majestic Hotel. Visiting geologists are welcome to all meetings.

MICHIGAN

MICHIGAN GEOLOGICAL SOCIETY

President - - - - - - - - Ben F. Hake
Gulf Refining Company
Vice-President - - - - - - A. E. Newman
Department of Conservation
Secretary-Treasurer - - - - - K. W. Beck
The Carter Oil Company
240 Goff Building, Saginaw
Business Manager - - - - - S. G. Berquist
Michigan State College

Meetings: Monthly dinner meetings rotating between Saginaw, Mt. Pleasant, and Lansing. Informal dress.

OKLAHOMA

ARDMORE GEOLOGICAL SOCIETY

ARDMORE, OKLAHOMA

President - - - - - - Jerome M. Westheimer
Consulting Geologist

Vice-President - - - - - - - - - O. H. Hill
Shell Petroleum Corporation

Secretary-Treasurer - - - - - - - - J. P. Gill
Sinclair Prairie Oil Company

Chairman Program Committee - - Don L. Hyatt
Carter Oil Company, Dillard, Oklahoma

Meetings: First Tuesday of each month, from October to May, inclusive, at 7:30 P.M., Dornick Hills Country Club.

OKLAHOMA CITY GEOLOGICAL SOCIETY

OKLAHOMA CITY, OKLAHOMA

President - - - - - - - - E. A. Paschal
Coline Oil Company

Vice-President - - - - - Dan O. Howard
Oklahoma Corporation Commission

Secretary-Treasurer - - - - - C. E. Hamilton
Harper and Turner, 504 Hightower Building

Meetings, Ninth Floor, Commerce Exchange Building: Technical Program, second Monday, each month, 8:00 P.M.; Luncheons, every Monday, 12:15 P.M.

SHAWNEE GEOLOGICAL SOCIETY

SHAWNEE, OKLAHOMA

President - - - - - - - - A. M. Meyer
Atlantic Refining Company

Vice-President - - - - - - - V. G. Hill
Stanolind Oil and Gas Company

Secretary-Treasurer - - - J. Lawrence Muir
Amerada Petroleum Corporation

Meets the fourth Monday of each month at 8:00 P.M., at the Aldridge Hotel. Visiting geologists welcome.

THE STRATIGRAPHIC SOCIETY OF TULSA

TULSA, OKLAHOMA

President - - - - - - - - - - L. H. Lukert
The Texas Company

Vice-President - - - - - - - L. A. Johnston
Sunray Oil Company

Secretary-Treasurer - - Constance Leatherock
Tide Water Associated Oil Company

Meetings: Second and fourth Wednesdays, each month, from October to May, inclusive, at 8:00 P.M.

TULSA GEOLOGICAL SOCIETY

TULSA, OKLAHOMA

President - - - - - - - - - Robert J. Riggs
Stanolind Oil and Gas Company

1st Vice-President - - - - - - - - N. W. Bass
United States Geological Survey

2nd Vice-President - - - - Robert B. Wing
Shell Petroleum Corporation

Secretary-Treasurer - - - - - L. A. Johnston
Sunray Oil Company

Editor - - - - - - - - R. V. Hollingsworth
Shell Petroleum Corporation

Meetings: First and third Mondays, each month, from October to May, inclusive, at 8:00 P.M., fourth floor, Tulsa Building. Luncheons: Every Thursday, fourth floor, Tulsa Building.

TEXAS

DALLAS PETROLEUM GEOLOGISTS

DALLAS, TEXAS

President - - - - - - Dilworth S. Hager
932 Liberty Building

Vice-President - - - - - - - R. E. Rettger
Sun Oil Company

Secretary-Treasurer - - - W. W. Clawson
Magnolia Petroleum Company

Meetings: Regular luncheons, first Monday of each month, 12:15 noon, Petroleum Club. Special night meetings by announcement.

EAST TEXAS GEOLOGICAL SOCIETY

TYLER, TEXAS

President - - - - - - - - A. C. Wright
Shell Petroleum Corporation

Vice-President - - - - - - E. M. Rice
Pure Oil Company

Secretary-Treasurer - - - - F. J. Schempf
Stanolind Oil and Gas Company

Meetings: Monthly and by call.
Luncheons: Every Friday, Blue Room, Blackstone Hotel.

TEXAS

FORT WORTH GEOLOGICAL SOCIETY
FORT WORTH, TEXAS

President - - - - - - - - A. L. Ackers
Stanolind Oil and Gas Company

Vice-President - - - - Clarence E. Hyde
1715 W. T. Waggoner Building

Secretary-Treasurer - - Herbert H. Bradfield
The Texas Company

Meetings: Luncheon at noon, Worth Hotel, every Monday. Special meetings called by executive committee. Visiting geologists are welcome to all meetings.

HOUSTON GEOLOGICAL SOCIETY
HOUSTON, TEXAS

President - - - - - - - - David Perry Olcott
Humble Oil and Refining Company

Vice-President - - - - - - R. A. Weingartner
Stanolind Oil and Gas Company

Secretary-Treasurer - - - Carleton D. Speed, Jr.
Speed Oil Company

Regular meetings held every Thursday at noon (12 o'clock) above Kelly's Restaurant, 910 Texas Avenue. For any particulars pertaining to the meetings write of call the secretary.

NORTH TEXAS GEOLOGICAL SOCIETY
WICHITA FALLS, TEXAS

President - - - - - - - Tom F. Petty
Humble Oil & Refining Company

Vice-President - - - - Paul E. M. Purcell
Shell Petroleum Corporation

Secretary-Treasurer - - - Orion A. Daniel
Consulting Geologist
814 Hamilton Building

Luncheons and evening programs will be announced.

SOUTH TEXAS GEOLOGICAL SOCIETY
SAN ANTONIO AND CORPUS CHRISTI TEXAS

President - - - - - - - - W. A. Maley
Humble Oil and Refining Company, Corpus Christi

Vice-President - - - - - - W. W. McDonald
Arkansas Natural Gas Company, San Antonio

Secretary-Treasurer - - - - - - C. C. Miller
The Texas Company, Corpus Christi

Executive Committee - - - - - D. G. Barnett

Meetings: Third Friday of each month at 8 P.M. at the Petroleum Club. Luncheons every Monday noon at Petroleum Club, Alamo National Building, San Antonio, and at Plaza Hotel, Corpus Christi.

SOUTHWESTERN GEOLOGICAL SOCIETY

President - - - - - - - Duncan McConnell
Univ. Texas, Dept. of Geology

Vice-President - - - - - - Leo Hendricks
Bureau of Economic Geology

Secretary-Treasurer - - - - - - W. C. Ikins
Univ. Texas, Dept. of Geology

Meetings: Every third Friday at 8:00 P.M. at the University of Texas, Geology Building 14.

WEST TEXAS GEOLOGICAL SOCIETY
SAN ANGELO AND MIDLAND, TEXAS

President - - - - - - - - H. A. Hemphill
Magnolia Petroleum Company, Midland

Vice-President - - - - - - W. D. Anderson
Amerada Petroleum Corporation, Midland

Secretary-Treasurer - - - - - - - W. C. Fritz
Skelly Oil Company, Midland

Meetings will be announced

WEST VIRGINIA

THE APPALACHIAN GEOLOGICAL SOCIETY
CHARLESTON, WEST VIRGINIA
P.O. Box 1435

President - - - - - Robert C. Lafferty
Owens, Libbey-Owens Gas Department

Vice-President - - - J. Hawker Newlon
Philadelphia Gas Company
Pittsburgh, Pennsylvania

Secretary-Treasurer - - - Charles Brewer, Jr.
Godfrey L. Cabot, Inc., Box 348

Meetings: Second Monday, each month, at 6:30 P.M., Kanawha Hotel.

THE SOCIETY OF EXPLORATION GEOPHYSICISTS

President - - - - - - F. M. Kannenstine
Kannenstine Laboratories, Houston, Texas
2011 Esperson Building

Vice-President - - - - - - - - W. T. Born
Geophysical Research Corporation
Tulsa, Oklahoma

Editor - - - - - - - M. M. Slotnick
Humble Oil & Refining Co., Houston, Texas

Secretary-Treasurer - - - - - - H. B. Peacock
Geophysical Service, Inc., Houston, Texas
825 Esperson Building

STRUCTURAL EVOLUTION OF SOUTHERN CALIFORNIA

By R. D. Reed and J. S. Hollister

is available in the standard binding of the Association: blue cloth, gold stamped, 6 x 9 inches, with colored map in pocket. Postpaid, $2.00. Extra copies of the tectonic map, 27 x 31 inches, on strong ledger paper in roll: postpaid, $0.50.

The American Association of Petroleum Geologists, Box 979, Tulsa, Oklahoma

GEOGEL *HI SPEED*

GEOTUBE

ILLINOIS POWDER MFG. CO.

REVUE DE GÉOLOGIE
et des Sciences connexes

REVIEW OF GEOLOGY
and Connected Sciences

RASSEGNA DI GEOLOGIA
e delle Scienze affini

RUNDSCHAU FÜR GEOLOGIE
und verwandte Wissenschaften

Abstract journal published monthly with the coöperation of the FONDATION UNIVERSITAIRE DE BELGIQUE and under the auspices of the SOCIÉTÉ GEOLOGIQUE DE BELGIQUE with the collaboration of several scientific institutions, geological surveys, and correspondents in all countries of the world.

GENERAL OFFICE, *Revue de Géologie*, Institut de Géologie, Université de Liége, Belgium.

TREASURER, *Revue de Géologie*, 35, Rue de Armuriers, Liége, Belgium.

Subscription, Vol. XVIII (1938), 35 belgas *Sample Copy Sent on Request*

The Annotated

Bibliography of Economic Geology
Vol. XI, No. 1

Will Be Ready in January

Orders are now being taken for the entire volume at $5.00 or for individual numbers at $3.00 each. Volumes I-X can still be obtained at $5.00 each.

The number of entries in Vols. IX and X is 4,997.

Of these, 1,348 refer to *petroleum, gas,* etc., and *geophysics.* They cover the world.

If you wish future numbers sent you promptly, kindly give us a *continuing* order.

An Index of the 10 volumes will be issued in December. Price: $5.00

Economic Geology Publishing Co.
Urbana, Illinois, U.S.A.

"Petroleum"

Magazine for the interests of the whole Oil Industry and Oil Trade.

Subscription (52 issues per annum) $18

"Tägliche Berichte
über die Petroleumindustrie"
("Daily Oil Reports.")

Special magazine for the interests of the whole Oil Industry and Oil Trade

Subscription: $40

VERLAG FÜR FACHLITERATUR
Ges.m.b.H.

BERLIN SW. 68, Wilhelmstrasse 147.
VIENNA XIX/1, Vegagasse 4.

WE BANK ON OIL
1895 — 1938

THE
FIRST NATIONAL BANK AND TRUST COMPANY
OF TULSA

THE GEOTECHNICAL CORPORATION

Roland F. Beers
President

902 Tower Petroleum Building
Telephone L D 711 Dallas, Texas

Verlag von Gebrüder Borntraeger in Berlin und Leipzig

Einführung in die Geologie, ein Lehrbuch der inneren Dynamik, von Professor Dr. H. Cloos. Mit 1 Titelbild, 3 Tafeln und 356 Textabbildungen (XII und 503 Seiten) 1936 Gebunden *RM* 24.—

Das Buch will den überreichen Forschungsstoff der letzten Jahrzehnte so darstellen, daß sich auch Fernerstehende von dem Bau, der stofflichen Zusammensetzung und den Bewegungsvorgängen in der Kruste unseres Planeten ein Bild machen können. Die Darstellung geht überall von den Tatsachen und zwar, so weit wie möglich, von den tatsächlichen Bewegungen aus und endigt bei ihrer gedanklichen Auswertung. Auf die Interessen der Praxis, besonders des Bergbaus, ist überall Bezug genommen, die Verbindung mit dem Leben nach Möglichkeit ständig gewahrt. Das Buch sollte auch den nicht mit gelehrtem Gepäck belasteten Wanderer im Gebirge führen können.

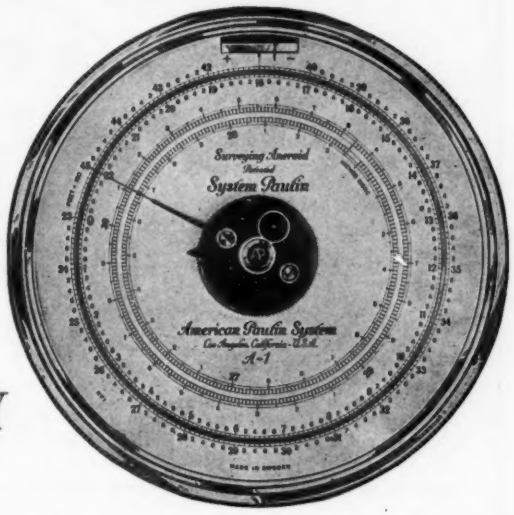
Die Beispiele stammen aus allen Teilen der Erde, nicht zuletzt aus Skandinavien, Indien, Nordamerika und Afrika. Aber Deutschland und seine früheren außereuropäischen Besitzungen sind bevorzugt.

Für den Verfasser gibt es in der Erde keine Einzeldinge und nichts Fertiges. Er versucht, die Tatsachen in ihren Zusammenhängen vorzuführen (Bewegungen, Kreisläufe, Abstauungen, Entwicklungen usw.), und möchte alle Erkenntnisse aufgefaßt wissen als Pflastersteine in einer Straße zur Lösung eines letzten, zentralen Problems der Gesamterde. Lücken in diesem Pflaster werden nicht überkleistert, sondern deutlich umschrieben. Das Buch will also nicht nur in seinem Stoff ein dynamisches sein.

Ausführliche Einzelprospekte kostenfrei

This NEW Paulin
LEVELING ALTIMETER

Brings New Speed and Efficiency to the work of
RUNNING PRELIMINARY SURVEYS



Preliminary surveys and contour work are simplified and speeded up where the New Paulin Leveling Aneroid is part of the field equipment. This super-sensitive instrument saves hours and days by providing quick readings on differences of elevation. Corrections for barometric changes are easily and quickly computed. The sensitivity of this instrument makes it possible to measure differences as slight as one foot. The dial is graduated to 2-foot intervals over a range of 4200 feet. Barometric scale on face of dial corresponds to the full range of the altimetric scale, with readings graduated to .01″ of mercury from 26″ to 30.80″. This instrument, upon specification, can be furnished to operate under excessive pressures in low altitudes.

The Paulin Leveling Aneroid is furnished with a handy carrying case of heavy sole leather, fitted with hand and shoulder straps. Weight, only 18 oz.; dial, 4¾″ diameter. Send for folder and learn more about this remarkable new instrument.

AMERICAN PAULIN SYSTEM **Pet-Geol-12**
1847 South Flower St., Los Angeles, California

Send me by return mail a copy of your circular describing the New 1938 line of Paulin Leveling Aneroids.

Name .....

Address ..... Post Office .....

Company .....

PRACTICAL PETROLEUM ENGINEERS' HANDBOOK

BY JOSEPH ZABA, E.M.M.Sc.
Petroleum Engineer, Rio Bravo Oil Company
and
W. T. DOHERTY
Division Superintendent, Humble Oil & Refining Company

For a number of years there has been a growing demand for a handbook containing formulae and other practical information for the benefit of the man working in the production and drilling branches of the oil industry. So great has been this need that many engineers have tried to accumulate their own handbooks by clipping tables, formulae and figures from scores of sources.

The co-authors of this volume discovered by coincidence that each had been for a period of several years accumulating practical data which through their collaboration appears in this book. Both of them are men who have not only received theoretical training but who have had many years of practical experience as engineers in dealing with every day oil field drilling and production problems.

As a result of this collaboration of effort the publishers of this volume feel that it is a most valuable contribution to oil trade literature.

Its purposes are distinctly practical. The tables, formulae, and figures shown are practical rather than theoretical in nature. It should save the time of many a busy operator, engineer, superintendent, and foreman.

TABLE OF CONTENTS

Chapter I—General Engineering Data
Chapter II—Steam
Chapter III—Power Transmission
Chapter IV—Tubular Goods
Chapter V—Drilling
Chapter VI—Production
Chapter VII—Transportation

Semi-Flexible Fabrikoid Binding, Size 6 x 9, 408 pages—Price $5.00 Postpaid

Send check to

THE GULF PUBLISHING COMPANY

P. O. Drawer 2811 Houston, Texas

SPECIAL PUBLICATIONS

THE AMERICAN ASSOCIATION OF PETROLEUM GEOLOGISTS

Box 979, Tulsa, Oklahoma

1929	**Structure of Typical American Oil Fields.** Symposium on relation of oil accumulation to structure. By many authors. Originally in 2 volumes. Vol. I, exhausted. Vol. II, 780 pp., 235 illus. 6 x 9 inches. Cloth. **To members and associates, Vol. II, $5.00** ..... **Vol. II**	**$ 7.00**
1935	**Geology of Natural Gas.** Symposium on occurrence and geology of natural gas in North America. By many authors, 1,227 pp., 250 illus. 6 x 9 inches. Cloth. **To members and associates, $4.50**	**6.00**
1936	**Geology of the Tampico Region, Mexico.** By John M. Muir. 280 pp., 15 half-tone plates, 41 line drawings, 9 tables. 6 x 9 inches. Cloth. **To members and associates, $3.50**	**4.50**
1936	**Gulf Coast Oil Fields.** Symposium on Gulf Coast Cenozoic. By 52 authors. Chiefly papers reprinted from the Association *Bulletin* of 1933-1936 gathered into one book. xxii and 1,070 pp., 292 figs., 19 half-tone pls. 6 x 9 inches. Cloth. **To members and associates, $3.00**	**4.00**
1936	**Structural Evolution of Southern California.** Sequel to **Geology of California.** By R. D. Reed and J. S. Hollister. 158 pp., 8 half-tone plates, 57 line drawings, 6 tables, 1 folded map in colors. Reprinted from December, 1936, *Bulletin*, bound in cloth. 6 x 9 inches	**2.00**
	Areal and Tectonic Map of Southern California, in colors, same as in book, 27 x 31 inches, rolled in mailing tube	**.50**
1937	**Comprehensive Index** of 20 volumes of the *Bulletin* and all special publications of the Association (1917-1936). By Daisy Winifred Heath. 382 pp., 6.75 x 9.5 inches. Paper. **To paid up members and associates, one copy free**	**3.00**
1938	**Miocene Stratigraphy of California.** By Robert M. Kleinpell. More than 300 pp., approx. 22 plates of fossil figures, 14 line drawings, 20 tables and charts. **To members and associates, $4.50**	**5.00**

Prices postpaid. Write for discount to colleges and public libraries.

In Oklahoma, add 2 per cent for sales tax.

THE GEOLOGY OF SOUTH-WESTERN ECUADOR

BY
GEORGE SHEPPARD
State Geologist of the Republic of Ecuador
With a chapter on THE TERTIARY LARGER FORAMINIFERA OF ECUADOR
By THOMAS WAYLAND VAUGHAN
Director of the Scripps Institution of Oceanography, LaJolla, California

The first book on the geology of Ecuador to be published in English.
The author has spent 10 years in studying the area.
The chapters on petroleum and on the foraminifera are of special interest to oil-field geologists.
The book is also of interest to geographers.
Published by Thomas Murby & Co., in London, 1937.

275 pp., 195 illustrations, maps, and diagrams. 5½ x 8½ inches. Cloth.
PRICE: Postpaid and import duty paid, $7.00
Specimen pages sent on request

ORDER FROM The American Association of Petroleum Geologists
Box 979, Tulsa, Oklahoma

GEOLOGY OF THE TAMPICO REGION, MEXICO

By JOHN M. MUIR

PART I. INTRODUCTORY. History. Topography. Drainage. (Pages 1-6.)
PART II. STRATIGRAPHY AND PALAEOGEOGRAPHY. Palaeozoic. Mesozoic. Tertiary. (7-142.)
PART III. IGNEOUS ROCKS AND SEEPAGES. Asphalt. Oil. Gas. (143-158.)
PART IV. GENERAL STRUCTURE AND STRUCTURE OF OIL FIELDS. Northern Fields and Southern Fields: Introduction, Factors Governing Porosity, Review of Predominant Features, Production, Description of Each Pool and Field, Natural Gas, Light-Oil Occurrences. (159-225.)
APPENDIX. Oil Temperatures. Salt-Water Temperatures. Well Pressures. Stripping Wells. Shooting and Acid Treating. Stratigraphical Data in Miscellaneous Areas. List of Wells at Tancoco. (226-236.)
BIBLIOGRAPHY (237-247). LIST OF REFERENCE MAPS (248). GAZETTEER (249-250). INDEX (251-280).

- **280 pages, including bibliography and index**
- **15 half-tones, 41 line drawings, including 5 maps in pocket**
- **212 references in bibliography**
- **Bound in blue cloth; gold stamped; paper jacket. 6 x 9 inches**

$4.50, post free
$3.50 to A.A.P.G. members and associates

The American Association of Petroleum Geologists
BOX 979, TULSA, OKLAHOMA, U.S.A.

UNITED GEOPHYSICAL COMPANY

PASADENA • CALIFORNIA

Geology

applied to oil-field problems

Here is a clear and concise work on the occurrence of oil, and its geology, giving the reader a well-rounded picture of the value of geology to the oil business.

Just Out!

New, up-to-date 5th edition

Practical Oil Geology

By DORSEY HAGER

466 pages, fully illustrated, $4.00

This is a guidebook of all-round interest for the oil geologist, producer, and engineer. Descriptive and reference materials are combined to cover every phase of prospecting for oil and exploiting oil fields in which geologic science is applied.

For 23 years, through four editions, this book has been a standard guide to the application of geology to oil-field development and engineering. Now again it has been revised to give readers practical information on newest developments in the field.

May be ordered from

THE AMERICAN ASSOCIATION OF PETROLEUM GEOLOGISTS
BOX 979, TULSA, OKLAHOMA, U.S.A.

GULF COAST OIL FIELDS

FIFTY-TWO AUTHORS

Forty-Four Papers Reprinted from the *Bulletin* of The American Association of Petroleum Geologists with a Foreword by Donald C. Barton

EDITED BY

DONALD C. BARTON
Humble Oil and Refining Company
AND
GEORGE SAWTELLE
Kirby Petroleum Company

THE INFORMATION IN THIS BOOK IS A GUIDE FOR FUTURE DISCOVERY

- **1,084 pages, 292 line drawings, 19 half-tone plates**
- **Bound in blue cloth; gold stamped; paper jacket; 6x9 inches**

PRICE: $4.00, EXPRESS OR POSTAGE FREE
($3.00 to A.A.P.G. members and associate members)

THE AMERICAN ASSOCIATION OF PETROLEUM GEOLOGISTS
BOX 979, TULSA, OKLAHOMA, U.S.A.
London: Thomas Murby & Co., 1, Fleet Lane, E.C. 4

Production

in Illinois with the Failing "55"

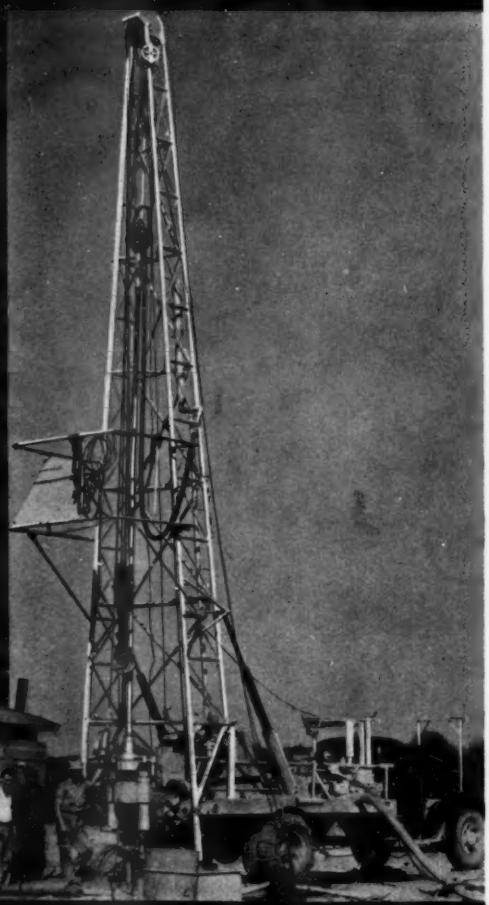
This photo shows a Failing truck-mounted "55" drill in actual operation in the Illinois basin. For slim holes and shallow production at 1500 to 2000 feet this drill is doing the job thoroughly and economically.

Pumping equipment may be mounted separately on skids or truck.

—If you have a drilling problem, write . . .

GEO. E. FAILING SUPPLY COMPANY

Enid, Okla. Houston, Texas



F

"Cores Will Tell"

Continuous **ELECTRICAL PROFILING**

provides ACCURACY, SPEED and DEFINITE RESULTS at a surprisingly LOW COST

For Fluid Level Determinations, use the Electrical ECHO-METER. Greatest accuracy is assured with a Steep Front Wave measuring device on which there are United States Patents pending covering the methods and apparatus.

Sole Licensees under JAKOSKY Patents, U.S. Nos. 2105247, 2015401 and 1906271 ...Canadian Patent No. 374475. Other U.S. and Foreign Patents Pending Covering Apparatus and Method.

INTERNATIONAL GEOPHYSICS, INC.

ORGANIZED IN 1929

1063 GAYLEY AVE., LOS ANGELES, CALIFORNIA

P. O. BOX 392, GREAT BEND, KANSAS
P. O. BOX 188, LOVINGTON, NEW MEXICO
P. O. Box 1499, KILGORE, TEXAS

STRATIGRAPHIC PROSPECTING

BY

GEOPHYSICS AND GEOCHEMISTRY

ELECTRICAL TRANSIENT SURVEYS

ANALYSES
OF
SOILS AND GAS SEEPS
FOR
HYDROCARBONS
AND
ASSOCIATED SIGNIFICANT CONSTITUENTS

SUBTERREX

321 ESPERSON BLDG.
HOUSTON, TEXAS

BACK VOLUMES AT HALF PRICE

Members and associate members of the Society of Economic Paleontologists and Mineralogists and of the Paleontological Society and subscribers of the

JOURNAL OF PALEONTOLOGY

will be privileged for a limited time to purchase complete Volumes 2 (1928) to 11 (1937) at the very special price of Three Dollars ($3.00) per volume. This offer represents a 50 per cent discount from regular prices and gives opportunity that should not be overlooked. Furthermore, only part of the supply of back volumes will be sold at this price. The stock of Volume 1 is exhausted, but any others can be purchased. Place order promptly if you wish to secure discount because this offer will be withdrawn as soon as allotment of copies is exhausted.

Separate numbers from broken sets of back volumes will be sold to members, associate members, and subscribers at the special price of Twenty-Five Cents ($0.25). This offer is open only while the supply lasts. Available at present are: Vol. 2, Nos. 2, 4; Vol. 3, Nos. 1, 2, 4; Vol. 4, Nos. 3, 4, and Supplement; Vol. 5, Nos. 1, 2, 3; Vol. 6, Nos. 2, 3, 4; Vol. 7, Nos. 3, 4; Vol. 8, Nos. 3, 4; Vol. 9, Nos. 1, 3, 4, 5, 6, 7, 8; Vol. 10, Nos. 1, 4, 5, 8; Vol. 11, Nos. 3, 4, 7, 8.

Members and associate members of the Society of Economic Paleontologists and Mineralogists and subscribers of the

JOURNAL OF SEDIMENTARY PETROLOGY

may purchase, for a limited time, complete Volumes 1 (1931) to 7 (1937), at half price, One Dollar and a Half ($1.50) per volume.

Separate numbers from broken sets of back volumes will be sold to members, associate members, and subscribers at the special price of Twenty-Five Cents ($0.25). Available at present are: Vol. 1, No. 2; Vol. 2, Nos. 1, 3; Vol. 3, Nos. 1, 3; Vol. 4, Nos. 2, 3; Vol. 5, Nos. 1, 2; Vol. 6, Nos. 1, 3; Vol. 7, Nos. 2, 3.

All prices, postpaid

Send orders to

SOCIETY OF ECONOMIC PALEONTOLOGISTS AND MINERALOGISTS
Box 979, Tulsa, Oklahoma

Rendering to Petroleum Science a Mapping Service Fitted By Accuracy, Versatility, and Economy to Every Phase of Exploration Activity.

» Full Details on Request «

EDGAR TOBIN AERIAL SURVEYS

SAN ANTONIO

San Antonio
Box 2101
Persh. 9141

Houston
Box 2286
Preston 9608

Leitz

OIL FIELD MICROSCOPE
RBM

The ideal companion
for
"sitting on a well"

Ask for catalog No. 1264

E. LEITZ, INC.
(Makers of the famous LEICA Cameras)
730 FIFTH AVENUE, NEW YORK, N. Y.
WASHINGTON · CHICAGO · DETROIT
Western Agents: Spindler and Sauppe, Inc., Los Angeles - San Francisco

TO AVOID TROUBLE
use
BAROID PRODUCTS

USE AQUAGEL for a trouble-free drilling mud and for conditioning.
USE BAROID to help prevent blow-outs and to help control caving.
USE STABILITE to help prevent gas-cutting and to maintain muds at workable viscosities.
USE BAROCO to avoid trouble in drilling through salt and salt water.
USE FIBROTEX to help prevent bad losses of circulation.

Use BAROID Testing Equipment to aid in maintaining the uniform quality of the drilling mud.

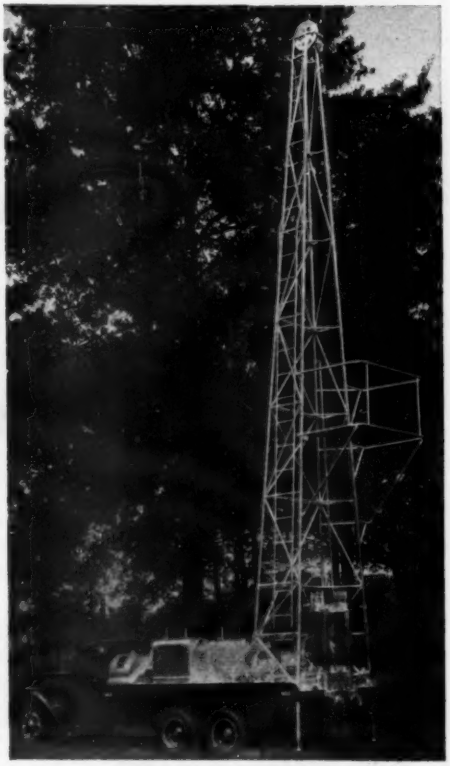
Stocks carried and service engineers available in all active oil fields. Look for this trade mark under "Oil Well Drilling Mud" in your classified telephone directory for our nearest service engineer and distributor.

BAROID SALES DEPARTMENT
NATIONAL PIGMENTS & CHEMICAL DIVISION
NATIONAL LEAD COMPANY
BAROID SALES OFFICES—LOS ANGELES · TULSA · HOUSTON

32115 FEET IN A MONTH

One drill completes 32115 feet of 1000 foot holes in one month, for electrical logging surveys.

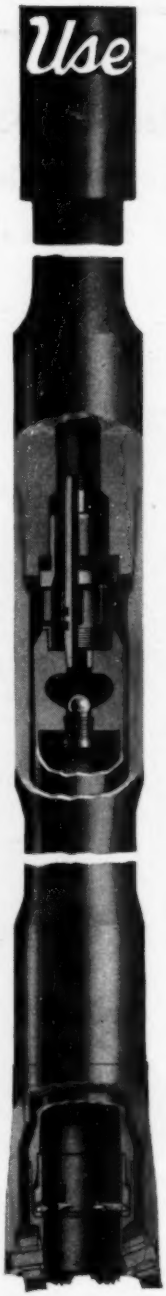
Below: A 41 on International Truck.
Left: A 41 on Marmon Herrington Truck.



For core drilling and electrical logging holes, the 41 sets new concepts of speed and safety. The automatic chuck and sensitive hydraulic feed for both rods and kelly are two of the many exclusive features responsible for the "stand out" performance of the 41 in both domestic and foreign fields.

SULLIVAN
MACHINERY COMPANY
Michigan City, Indiana
Claremont, New Hampshire

SALES OFFICES AT:
1914 Commerce Street Dallas
30 Church Street, New York City
Houston—Denver—Los Angeles
and principal cities throughout the world.



the **REED**

Kor-King

CORE DRILL

FOR

GREATER RECOVERY

OF

LARGER DIAMETER

CORES

COMBINATION SPRING AND TOGGLE TYPE CORE CATCHER

TOGGLE TYPE CORE CATCHER (UNIFIED CONSTRUCTION)

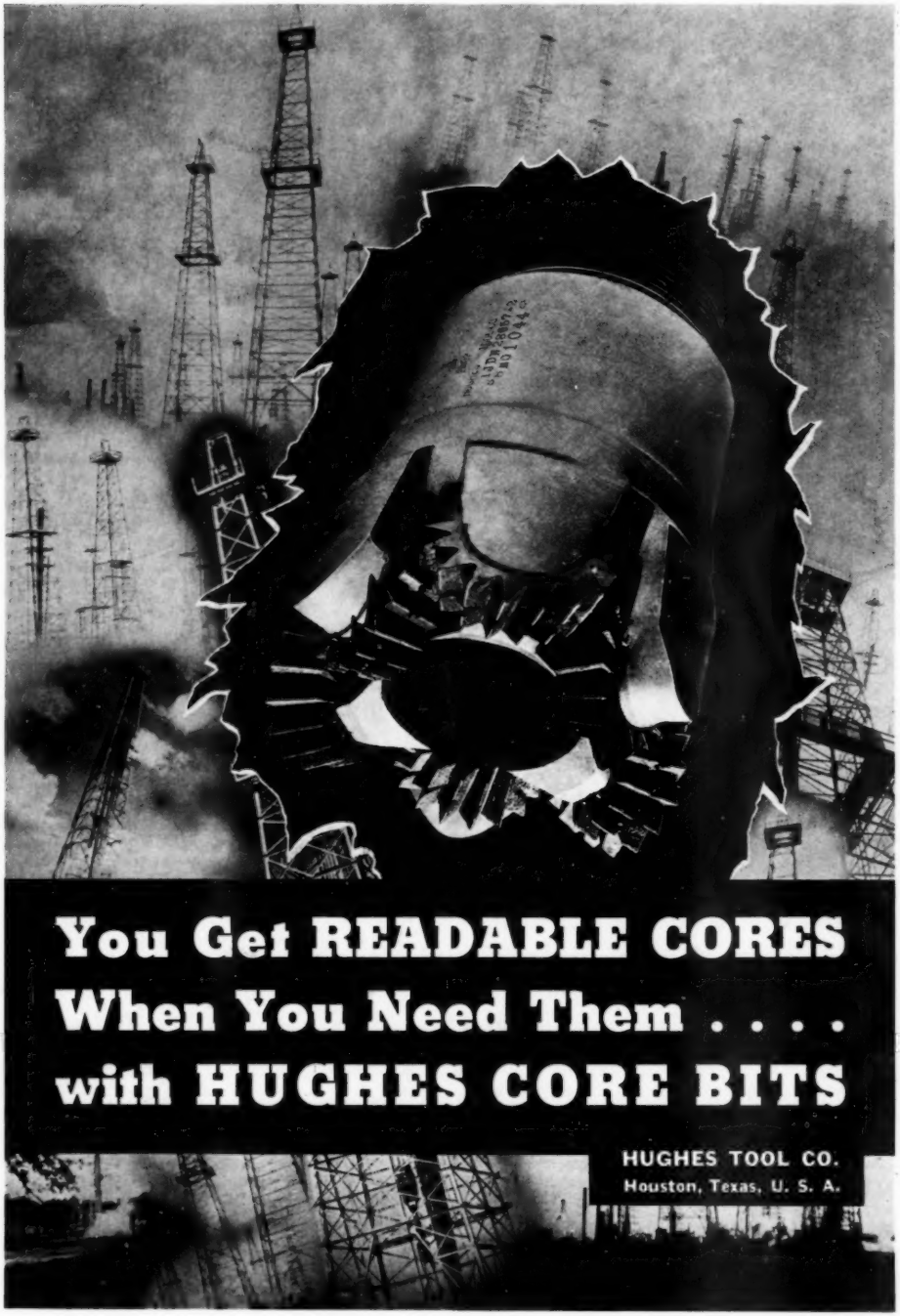
REED

ROLLER BIT CO.

REED ROTARY DRILLING TOOLS

P. O. BOX 2119 — HOUSTON, TEXAS

G.S.I. goes Eastward
to the land of
the rising sun
ARABIA
SUMATRA
JAVA
NEW GUINEA
G S I
THROUGH ACHIEVEMENT YOU KNOW THIS COMPANY
GEOPHYSICAL SERVICE · INC
REFLECTION SEISMIC SURVEYS DALLAS TEXAS


You Get READABLE CORES
When You Need Them . . . .
with HUGHES CORE BITS
HUGHES TOOL CO.
Houston, Texas, U. S. A.